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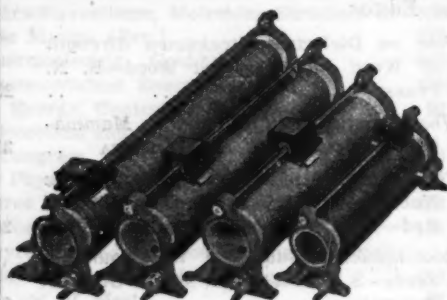
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# HIGH RESOLUTION RAMAN SPECTROSCOPY AND THE STRUCTURE OF SIMPLE MOLECULES

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THE numerous investigations of the vibrational Raman spectra of molecules have made significant contributions to the development of our present ideas of molecular structures. From the frequencies, relative intensities and depolarization factors of vibrational Raman bands, valuable data on molecular symmetry, force constants and thermodynamic quantities have been obtained for a vast number of simple molecules. Usually, these data have been obtained from the Raman spectra of liquids, photographed at low dispersion.

Additional and much more precise information about the structure of molecules can be obtained from the investigation of the rotational Raman spectra of gases. When the rotational line structure is resolved, it can lead to the evaluation of moments of inertia and hence internuclear distances and valence angles.

Immediately after the discovery of the Raman effect in 1928, observations of the rotational Raman spectra of diatomic and simple polyatomic molecules were reported by McLennan and McCord, Rasetti, Wood, Dickinson, Dillon and Rasetti, Amaldi and Placzek, Lewis and Houston, Bhagavantam, and Teal and McWood. The results were of great significance for the development of the theory of the new effect as well as for a better understanding of molecular physics. In addition, these early experiments and the theory of Placzek and Teller clearly outlined the advantages and potentialities of rotational Raman spectroscopy for the determination of molecular structures. Nevertheless, until recently this experimental technique has not been used for structural determinations to any great extent.

Experimentally, the investigation of the Raman spectra of gases has been a difficult problem because of the low intensity of Raman scattering. The difficulties are further increased if the Raman spectra are to be photographed with sufficient resolution to separate the rotational lines. On the one hand, low gas pressures must be used to prevent excessive line broadening, and this of course reduces the amount of scattered light. On the other hand, it is desirable to use spectrographs of high resolving power, up to 100,000 but unfortunately

these are usually of low light-gathering power. Therefore a light source of very high intensity must be used to excite the Raman spectra and the scattered light must be collected and used with the utmost efficiency.

Recent improvements in apparatus have helped to overcome these difficulties to some degree so that Raman spectra of certain gases can now be photographed at high resolution with reasonably short exposure times. The major developments in apparatus include:

(a) a low pressure mercury arc operated at 20 to 30 amperes which emits sharp lines of high intensity with negligible continuum (Welsh, Crawford, Thomas and Love<sup>1</sup> and Stoicheff<sup>2</sup>).

(b) a system of concave mirrors of high reflectance in a long Raman tube which can superimpose about 40 cones of scattered light and therefore increase the efficiency of the Raman tube by almost this factor (Welsh, Cumming and Stansbury<sup>3</sup>). This high increase in efficiency over the conventional single-cone Raman tube arises in the following way. When the gas in the tube is irradiated, the molecules scatter light in all directions. Ordinarily, only a single cone of light enters the spectrograph, but of course there are an infinite number of such cones of light within the tube, any one of which would serve equally well. If some of these cones could be superimposed somehow, an enormous increase in observed light intensity would result. The mirror system achieves this to a limited extent and as already mentioned a factor of about 40 has been gained in this way.

An apparatus built in this laboratory is shown in Fig. 1. The multi-cone Raman tube is illuminated along a length of one metre by four mercury lamps and is completely enclosed in a reflector coated with magnesium oxide. A detailed description of this apparatus is given in reference 2.

With this apparatus it has been possible to photograph the pure rotation spectra and the rotation vibration spectra of several gases, with a 21 ft. grating spectrograph. The spectra are excited by the Hg 4358 line. At this wavelength, the reciprocal linear dispersion in the

## 2 High Resolution Raman Spectroscopy & Structure of Simple Molecules [Current Science

second order of the grating is  $6.7 \text{ cm}^{-1}/\text{mm}$ . Gas pressures of 15 cm. to 35 cm. Hg are ordinarily used and exposure times vary from 1 to 20 hours. The slit width used is  $0.2 \text{ cm}^{-1}$ , equal to the width of the exciting line, and the closest spacing of rotational lines to be resolved to date is  $0.37 \text{ cm}^{-1}$ . The rotation vibration spectra are considerably fainter than the pure rotation spectra and therefore longer exposure times and higher gas pressures are necessary. The exposure times can be reduced by a factor of about 15, by placing a cylindri-

cal lens in the spectrograph in front of the photographic plate. higher light-gathering power than the 21 ft. grating. With this apparatus, Professor Welsh and his co-workers have obtained some extremely interesting and valuable results on molecular structures. They have shown that high resolution studies of the rotational structure in vibrational Raman bands are now practical, and have recently carried out such investigations with a Raman tube 20 ft. long.

Precise information about the geometrical structure of diatomic and simple polyatomic molecules can also be obtained by a study of

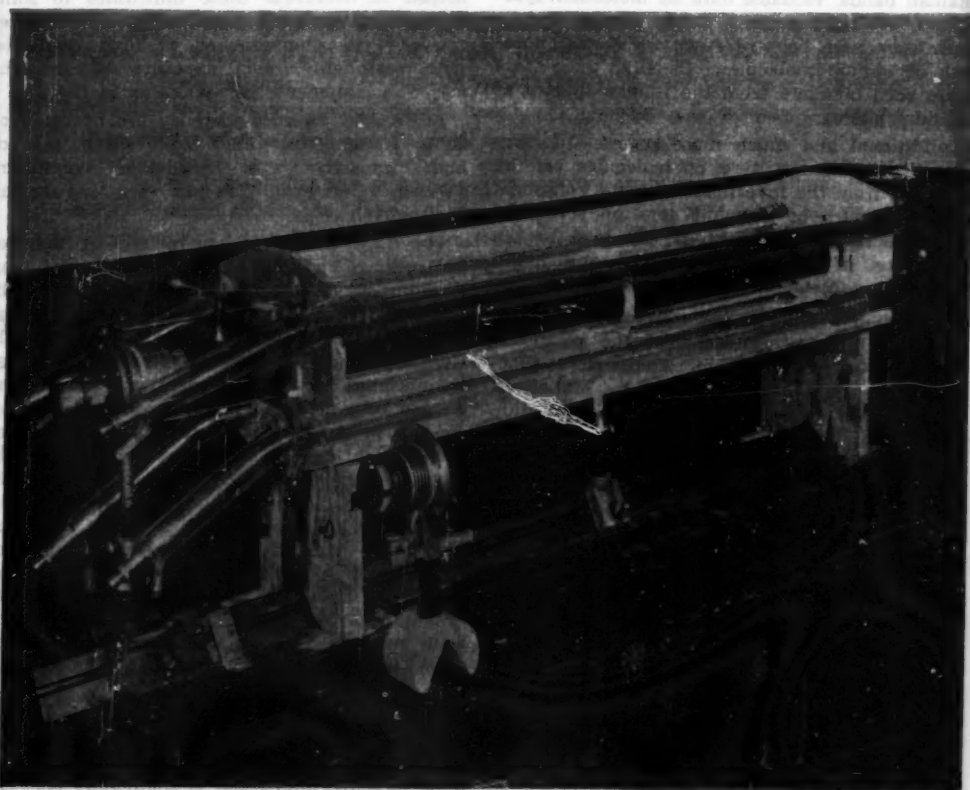


FIG. 1. An apparatus for high resolution Raman spectroscopy of gases. The rear mirrors are shown in the foreground. Electrical leads, water-cooling connections and part of the reflector housing have been removed.

cal lens in the spectrograph in front of the photographic plate.

A similar apparatus built at the University of Toronto<sup>4</sup> has been used primarily for the investigation of rotation vibration spectra. The Raman tube is illuminated along 150 cm., gas pressures up to four atmospheres are sometimes used, together with a prism spectrograph of

the rotational structure observed in their microwave, infrared and electronic spectra. While much valuable information has been obtained from these spectra there are inherent and experimental limitations in such investigations some of which can be overcome by a study of the rotational structure in Raman spectra. These limitations have to some extent dictated

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the problems which have been investigated by Raman spectroscopy. It may be worthwhile to discuss briefly some of these limitations, and to show how they may be overcome by investigations of Raman spectra.

All molecules with the exception of those with cubic symmetry have a pure rotational Raman spectrum. In contrast, only polar molecules exhibit rotation spectra in the microwave and far-infrared regions. As is well known, the same information about the ground state can be obtained from rotation-vibrational infrared spectra, but the vibration bands may be perturbed or overlapped by neighbouring bands and sometimes the rotational numbering cannot be ascertained. The pure rotation spectra are unperturbed, simple in appearance and usually easy to analyse. In the Raman effect, the exciting line defines the centre of the rotation spectrum and the rotational numbering can be determined unambiguously. Also, a check on the measurements is provided by a comparison of the Stokes and anti-Stokes lines.

For molecules with elements of symmetry the vibrational Raman spectra are complementary to the vibrational infrared spectra. The rotation-vibration spectra allow one to determine the effect of vibration on the rotational constants. Therefore the Raman and infrared vibration spectra must be investigated at high resolution if one is to eliminate the effect of zero point vibration and to determine the equilibrium structure. In addition, the rotational structure of certain vibrational bands is different in the Raman and infrared spectra. More rotational branches can appear in the Raman band and therefore valuable information can be obtained, which is not available from the infrared spectrum alone. These and other advantages will be illustrated by examples below.

For diatomic and linear polyatomic molecules the rotational energy levels of the ground state are given by the formula

$$\frac{E_r}{hc} = F_0(J) = B_0 J(J+1) - D_0 J^2(J+1)^2 + \dots \quad (1)$$

where  $E_r$  is the rotational energy in ergs,  $F_0(J)$  is the rotational term value in  $\text{cm}^{-1}$  and  $B_0 = h/(8\pi^2 c I_0)$ .

Here  $B_0$  is the rotational constant for the lowest vibrational level and is inversely proportional to the moment of inertia,  $I_0$ , for this level.  $J$  is the rotational quantum number which represents the total angular momentum of the molecule in units  $h/2\pi$ . The constant  $D_0$  represents the influence of centrifugal distortion

and is very small compared to  $B_0$ . For a vibrating molecule  $B_0$  is replaced by  $B_v$  where

$$B_v = B_0 - \sum_i a_i (v_i + \frac{1}{2})$$

Here  $B_v$  is the rotational constant for the equilibrium position and the  $a_i$  are small constants which determine the dependence of  $B$  on the different vibrations.

The occurrence of a pure rotational Raman spectrum for linear molecules (non-polar as well as polar), is due to the fact that the polarizability in a fixed direction changes during a rotation of the molecule about an axis perpendicular to its internuclear axis. The selection rules for Raman transitions are  $\Delta J = 0, 2$ . The rule  $\Delta J = 0$  gives the unshifted Rayleigh line which defines the centre of the rotation spectrum and  $\Delta J = 2$  gives the Stokes and anti-Stokes rotational lines known as S branches. The displacements of the rotational lines (in units  $\text{cm}^{-1}$ ) from the Rayleigh line are given by the equation

$$|\Delta v| = 4B_0 \left( J + \frac{3}{2} \right) - 8D_0 \left( J + \frac{3}{2} \right)^3 \quad (2)$$

Therefore we obtain a series of very nearly equidistant lines on either side of the Rayleigh line with the spacing of successive lines being  $4B_0$ . The  $J$  numbering of the lines is unambiguously obtained from the quotient of the displacement of a given line and the spacing  $4B_0$ . Precise values of the constants in equation (2) are then obtained graphically, by plotting  $|\Delta v|/(J + 3/2)$  against  $(J + 3/2)^2$ . The intercept gives  $4B_0$  and the slope  $8D_0$ .

In Fig. 2, some examples of pure rotational Raman spectra are shown, photographed with the N.R.C. 21 ft. grating. It can be seen that the lines are sharp and well-resolved and therefore accurate measurements can be made. Almost as many anti-Stokes lines are observed as Stokes lines, contrary to vibrational Raman spectra where usually only Stokes lines are observed. This is readily explained by the large number of molecules which are thermally excited into the various rotational levels at room temperature whereas only the lowest vibrational levels ( $< 500 \text{ cm}^{-1}$ ) are populated to any appreciable extent.

Values of rotational constants  $B_0$ , moments of inertia  $I_0$ , and internuclear distances  $r_0$ , obtained for various molecules by Raman spectroscopy are collected in Table I.

The most accurate values of the constants for the ground states of  $\text{H}_2$  and  $\text{N}_2$  are obtained from their Raman spectra. Indeed it is only a

few months ago that the electronic spectrum of  $N_2$  in the vacuum ultraviolet has been photographed with sufficient resolution to determine the molecular constants with an accuracy approaching that of the Raman-effect values. The difficulty has been one of limited resolution and a lack of reliable wavelength standards in the vacuum ultraviolet region: in con-

trast the Raman spectra are photographed in a very favourable wavelength region. The Raman spectra of  $H_2$ , HD and  $D_2$  have provided precise values of  $\omega_1$  and  $B_0$ , as well as of the smaller yet significant constants  $D_0$  and  $H_0$  [the coefficient of the term  $J^3(J+1)^3$  in equation (1)]. In addition, the Raman results for the  $v=0$  and 1 levels of  $H_2$  and HD were com-

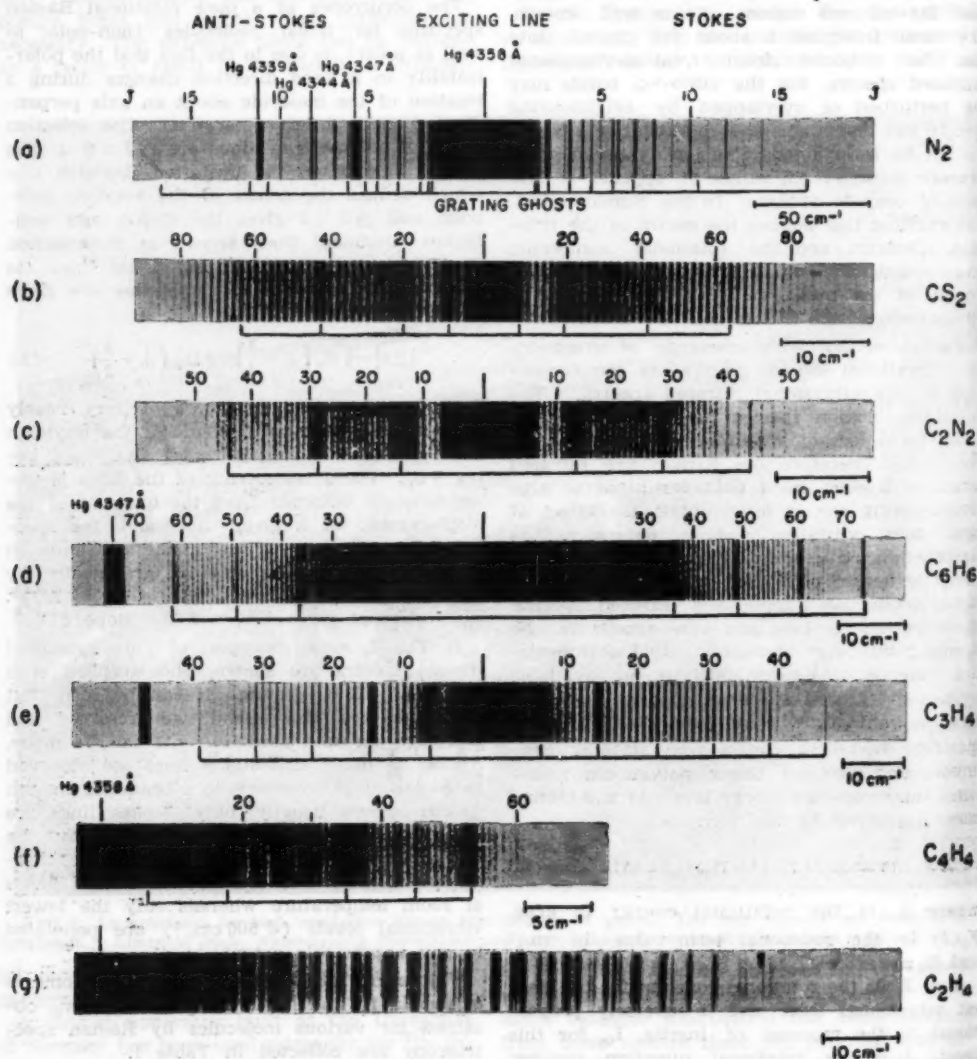


FIG. 2. Pure rotational Raman spectra photographed with a 21 ft. grating. (a) spectrum of  $N_2$ , (b, c) spectra of the linear molecules carbon disulphide and cyanogen, (d, e) spectra of the symmetric-top molecules, benzene and allene, (f, g) spectra (Stokes branches) of the slightly asymmetric-top molecules butatriene and ethylene.

TABLE I

Rotational constants, moments of inertia, and internuclear distances of molecules obtained from rotational Raman spectra

Molecule		$B_0$ (cm <sup>-1</sup> )	$I_0$ (10 <sup>-40</sup> g. cm. <sup>2</sup> )	$r_0$ (10 <sup>-8</sup> cm.)
Hydrogen	H <sub>2</sub>	59.339 <sub>2</sub>	0.47168	0.75105
	HD	44.667 <sub>8</sub>	0.62060	0.74973
	D <sub>2</sub>	29.910 <sub>5</sub>	0.93576	0.74820
Fluorine	F <sub>2</sub>	0.8828	31.70 <sub>5</sub>	1.418
Nitrogen	N <sub>2</sub>	1.9897 <sub>8</sub>	14.067	1.1000 <sub>8</sub>
Carbon Disulphide	CS <sub>2</sub>	0.10910	256.54	1.3545
Acetylene	C <sub>2</sub> H <sub>2</sub>	1.1709 <sub>2</sub>	23.782	$r$ (C=C) = 1.207
Cyanogen	C <sub>2</sub> N <sub>2</sub>	0.1575 <sub>2</sub>	177.69	$r$ (C-C) = 1.380
Ethylene	C <sub>2</sub> H <sub>4</sub>	1.008 <sub>5</sub>	27.75 <sub>8</sub>	$r$ (C=C) = 1.344
Allene	C <sub>3</sub> H <sub>4</sub>	0.2965 <sub>3</sub>	94.389	$r$ (C=C) = 1.309
	C <sub>3</sub> H <sub>2</sub> D <sub>2</sub>	0.2619 <sub>0</sub>	106.88 <sub>5</sub>	$r$ (C-H) = 1.07 ± .01
	C <sub>3</sub> H <sub>3</sub>	0.232 <sub>0</sub>	120.48 <sub>7</sub>	
Diacetylene	C <sub>4</sub> H <sub>2</sub>	0.1468 <sub>9</sub>	190.54	$r$ (C-C) = 1.376
	C <sub>4</sub> H <sub>3</sub>	0.1276 <sub>7</sub>	219.40	$r$ (C-H) = 1.043
	C <sub>4</sub> H <sub>4</sub>	0.1314 <sub>1</sub>	210.13	$r$ (C=C) = 1.284
Butatriene	C <sub>4</sub> H <sub>4</sub>	0.1122	249.4 <sub>8</sub>	
Dimethylacetylene	C <sub>4</sub> H <sub>6</sub>	0.1413	198.15	
Butadiene-1,3 (trans)	C <sub>4</sub> H <sub>6</sub>	0.1115	242.73	
Butene-2 (trans)	C <sub>4</sub> H <sub>8</sub>	0.1206	232.08	
	C <sub>4</sub> H <sub>7</sub>	0.1896 <sub>0</sub>	147.59	$r$ (C-C) = 1.397
Benzene	C <sub>6</sub> H <sub>6</sub>	0.1716 <sub>5</sub>	163.06	$r$ (C-H) = 1.084
	C <sub>6</sub> H <sub>5</sub>	0.1768 <sub>4</sub>	178.45	
	C <sub>6</sub> H <sub>4</sub>	0.2140 <sub>0</sub>	130.42	$r$ (C-N) = 1.338
s-Triazine	C <sub>3</sub> N <sub>3</sub> H <sub>3</sub>	0.1935 <sub>3</sub>	144.59	

bined with Herzberg's data for higher vibrational levels in order to determine a set of equilibrium constants for the ground electronic states of these molecules. It was possible to apply various small corrections for the coupling of electronic and nuclear motions and hence to check the isotopic rules and to determine precisely the interproton distance in the hydrogen molecule.

The rotational Raman spectrum of F<sub>2</sub><sup>6</sup> is of importance since the only known electronic spectrum involving the ground state is continuous and gives no information on the vibrational and rotational constants. Although the Raman spectrum was photographed at low dispersion, a fairly reliable value of the internuclear distance was obtained. In addition the 3:1 intensity alternation for odd: even J showed that the F<sup>19</sup> nuclei obey Fermi statistics and confirmed their spin of 1/2.

The rotation spectra of CS<sub>2</sub>, C<sub>2</sub>H<sub>2</sub>, C<sub>2</sub>N<sub>2</sub> and C<sub>2</sub>H<sub>4</sub> have led to values of rotational constants and internuclear distances, which are as precise or better than those obtained from infrared or electronic spectra. In the spectrum of CS<sub>2</sub> (Fig. 2b) only lines of even J appear since the spin of the S<sup>32</sup> nuclei is zero. Similarly the alternations of intensity observed in the

other spectra are in agreement with the linear symmetric structures of these molecules and with the known spin values and statistics of the nuclei.

For symmetric top molecules the rotational energy levels of a given vibrational level follow the formula

$$F_r(J, K) = B_r J(J+1) + (A_r - B_r) K^2$$

where  $A_r$  and  $B_r$ , apart from a constant, are the reciprocals of the moments of inertia  $I_r$  about the top axis and  $I_r$  about an axis perpendicular to the top axis. (Centrifugal distortion terms have been omitted.) The quantum number J represents the total angular momentum and K represents the component of J along the figure axis. The Raman selection rules for rotational transitions are  $\Delta K = 0$ ;  $\Delta J = 1, 2$ . It is readily seen that the lines of the S branch ( $\Delta J = 2$ ,  $\Delta K = 0$ ) are given by the same formula as for linear molecules, and lines of the R branch ( $\Delta J = 1$ ,  $\Delta K = 0$ ) have half the spacing of the S lines and therefore extend only half as far from the exciting line. The rule  $\Delta K = 0$  gives rise to a simple appearance of the spectrum although the spectrum really consists of a superposition of several branches, one for each K value. (The exactness of coincidence of the lines depends

on the smallness of the centrifugal distortion terms.) Also, the rule  $\Delta K=0$  accounts for the fact that the displacements of the rotational lines are only dependent on the constant  $B_0$  and not on  $A_0$ , that is only one moment of inertia can be determined from the spectrum.

One of the most interesting symmetric-top rotation spectra which has been studied is that of benzene shown in Fig. 2d. A series of well-resolved lines is observed on each side of the exciting line; these are the S branches with a line spacing of  $0.75 \text{ cm}^{-1}$ . Close to the exciting line there is a dense continuum partly due to overexposure of the exciting line and to grating ghosts, but mainly due to the R branch lines which are not resolved. The spectra of  $\text{C}_6\text{H}_6$  and  $\text{C}_6\text{D}_6$  were photographed and analysed, and as a check the spectrum of symmetric  $\text{C}_6\text{H}_5\text{D}_3$  was investigated (see Table I). A measurement of these spectra together with the assumption that benzene is planar and hexagonal gave the internuclear distances  $r_0(\text{C}-\text{C}) = 1.397 \pm 0.001 \text{ \AA}$  and  $r_0(\text{C}-\text{H}) = 1.084 \pm 0.005 \text{ \AA}$ .

At the time of the first announcement of these results, Cox and Smith<sup>8</sup> using modern X-ray methods obtained a value of  $1.378 \pm 0.003 \text{ \AA}$  for the C-C distance in crystalline benzene at  $-3^\circ \text{C}$ . Their value differed by  $0.02 \text{ \AA}$  from the Raman-effect value for the free molecule and represented a significant discrepancy. This led to a re-examination of the X-ray data and to the subsequent discovery that the thermal oscillations in the plane of the molecule are markedly anisotropic. Angular oscillations of the whole molecule, about its six-fold axis, with r.m.s. amplitudes as large as  $8^\circ$  were found. As a consequence of such motions the maxima of the time-averaged electron distributions for the carbon atoms appear to be closer to the centre of rotation and hence result in a shorter C-C distance. This correction amounts to about  $0.015 \text{ \AA}$  for the C-C distance which brings the X-ray value to  $1.392 \text{ \AA}$ ,<sup>9</sup> very close to the spectroscopic value.

Another molecule for which the effects of such angular motions have led to a discrepancy of  $0.02 \text{ \AA}$  between the Raman-effect and X-ray values of internuclear distances<sup>10</sup> is symmetrical triazine ( $\text{C}_3\text{H}_3\text{N}_3$ ). Corrections of this magnitude may well be significant in other accurate structure determinations.

A recent investigation of infrared bands of allene ( $\text{H}_2\text{C}=\text{C}=\text{CH}_2$ ) led to a value of  $1.30 \text{ \AA}$  for the length of the C=C bond, which is significantly shorter than the C=C bond in ethylene ( $1.344 \text{ \AA}$ ). Since this result is of considerable importance for valence theory an

investigation of the rotational Raman spectrum was undertaken and spectra of  $\text{C}_3\text{H}_4$  (Fig. 2e),  $\text{C}_3\text{HD}_4$  and  $\text{C}_3\text{H}_2\text{D}_2$  were photographed.<sup>11</sup> Slightly different values of the constants were obtained. Complications in the infrared spectra did not permit clear resolution of the lines and resulted in incorrect rotational numbering. However, the result that the C=C bond length in allene is shorter than that in ethylene was confirmed, the length of the allene bond being  $1.309 \pm 0.001 \text{ \AA}$ . The Raman data are also consistent with the values  $r(\text{C}-\text{H}) = 1.07 \pm 0.01 \text{ \AA}$  and  $\angle \text{HCH} = 117 \pm 1^\circ$ .

One of the most closely-spaced rotation spectra so far resolved by the Raman method is that of dimethylacetylene ( $\text{H}_3\text{C}-\text{C}\equiv\text{C}-\text{CH}_3$ ). The line spacing is  $0.45 \text{ cm}^{-1}$  and leads to the value of the large moment of inertia given in Table I.<sup>12</sup> This single result is of course inadequate for finding the dimensions of this molecule, but when the dimensions of the related molecule methylacetylene ( $\text{H}_3\text{C}-\text{C}\equiv\text{CH}$ ) are taken over,  $r(\text{C}-\text{C}) = 1.460 \text{ \AA}$ ,  $r(\text{C}\equiv\text{C}) = 1.207 \text{ \AA}$  and  $r(\text{C}-\text{H}) = 1.097 \text{ \AA}$ , it can be shown that the calculated moment of inertia is smaller than the experimental value. This would suggest that at least one of the bond lengths is slightly larger than the value found in methylacetylene.

The rotation spectra of several slightly asymmetric top molecules have been investigated including trans 2-butene, 1,3-butadiene, butatriene and ethylene. In appearance, all these spectra (except that of ethylene) resemble those of symmetric tops and indeed this is to be expected since K remains a good quantum number and the selection rules for symmetric tops ( $\Delta K=0$ ;  $\Delta J=1, 2$ ) still hold approximately. Therefore the analyses of these spectra can be carried out according to equation (2), but instead of the rotational constant  $B_0$  one obtains  $\frac{1}{2}(B_0 + C_0)$ . Again, as for symmetric tops, only the one constant is obtained and the lack of other data prevents the determination of the geometrical structures.

The present results for trans 2-butene ( $\text{H}_3\text{C}-\text{CH}=\text{CH}-\text{CH}_3$ ) are consistent with the following dimensions:  $r(\text{C}=\text{C}) = 1.344 \text{ \AA}$ ,  $r(\text{C}-\text{C}) = 1.500 \text{ \AA}$  and  $\angle (\text{C}-\text{C}-\text{C}) = 126^\circ$ . The observation of a resolved rotation spectrum for 1,3-butadiene ( $\text{H}_2\text{C}=\text{CH}-\text{CH}=\text{CH}_2$ ) shows that the trans form is the more stable configuration at room temperature: the cis form would give unresolved rotational bands. The results obtained for the normal as well as fully deuterated molecules are in agreement with the dimensions  $r(\text{C}=\text{C}) =$

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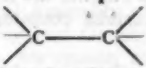

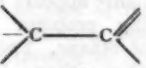

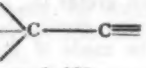
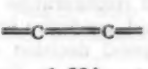
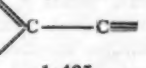
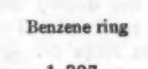
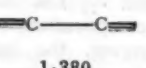
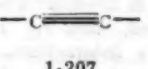
1.344 Å  $r(\text{C}-\text{C}) = 1.465$  Å and  $\angle (\text{C}=\text{C}-\text{C}) = 123^\circ$ .

Butatriene ( $\text{H}_2\text{C}=\text{C}=\text{CH}_2$ ) is of interest because the central  $\text{C}=\text{C}$  bond has a different environment to the  $\text{C}=\text{C}$  bonds in ethylene or allene. On the basis of the Raman data<sup>13</sup> and assumed dimensions for the  $\text{C}=\text{CH}_2$  and groups (same dimensions as in allene) a length of 1.284 Å was obtained for the central  $\text{C}=\text{C}$  bond of butatriene. This value is in good agreement with the length found by electron diffraction in carbon suboxide ( $\text{O}=\text{C}=\text{C}=\text{O}$ ) where the  $\text{C}=\text{C}$  bonds are similarly adjacent to double bonds, but an independent determination of the central  $\text{C}=\text{C}$  bond in butatriene is desirable.

Only for ethylene does the appearance of the spectrum deviate markedly from the simple rotational structure observed for symmetric top molecules. The ethylene molecule ( $\text{H}_2\text{C}=\text{CH}_2$ ) is favourable in this respect since it is relatively light and the main series of lines (R and S branches) therefore have a larger spacing than in the spectra discussed earlier. In addition to the R and S lines ( $\Delta K=0: \Delta J=1, 2$ ) which can be interpreted on the symmetric top approximation, a series of lines with smaller spacings than the S lines was observed (Romanko, Feldman, Stansbury and McKellar<sup>14</sup>). It was possible to explain this additional series on the basis of the asymmetric-top theory and to determine a value for the rotational constant  $C_0 = 0.8289 \text{ cm}^{-1}$ . As before, the R and S branches were used to evaluate  $\frac{1}{2}(B_0 + C_0)$ . While an improvement in these values may be possible from the spectrum recently photographed with the 21 ft. grating showing much finer detail (Fig. 2g), it should be noted that the earlier Raman investigation<sup>14</sup> was the first time that evidence of deviation from the symmetric top structure of ethylene has been obtained from its spectrum, and the results have stimulated a re-examination of the infrared spectrum of ethylene at high resolution.

The values of carbon-carbon distances obtained from rotational Raman spectra confirm and extend the data obtained by microwave and infrared spectra, and by recent accurate X-ray and electron diffraction investigations of similar molecules. From a compilation of accurate data it has been found<sup>15</sup> that the lengths of carbon-carbon single bonds are dependent on the type of adjacent bonds. A similar dependence is also proposed for carbon-carbon double bonds although not as many accurate data are avail-

able as for the single bonds. A summary of bond lengths (in Å) is given here:

	
1.544	1.344
	
1.500	1.309
	
1.460	1.284
	
1.425	1.397
	
1.380	1.207

The above values seem to be surprisingly independent (within  $\pm 0.005$  Å) of whether C, H, N, O or S atoms are adjacent to the carbons, and can therefore be used with some assurance in predicting the structure of molecules with these atoms, in the gas phase.

In spite of the difficulties already mentioned in photographing rotation-vibrational Raman bands at high resolution the spectra of  $\text{C}_2\text{H}_2$ ,<sup>16</sup>  $\text{C}_2\text{D}_2$ ,<sup>17</sup>  $\text{C}_2\text{H}_4$ ,<sup>18</sup>  $\text{C}_2\text{H}_6$ ,<sup>19</sup>  $\text{C}_3\text{H}_8$ ,<sup>20</sup>  $\text{CO}_2$ ,  $\text{CS}_2$ ,<sup>21</sup>  $\text{CH}_4$ ,<sup>22,23</sup> and  $\text{NH}_3$ <sup>24</sup> have been investigated. Considerable detail has been observed in each spectrum including extensive rotational structure for many of the bands. In a general way, each investigation has yielded new and worthwhile results, in some instances even when no rotational structure was observed.

Although no rotational structure was resolved in the spectrum of cyclopropane,  $\text{C}_3\text{H}_6$ , the intensity contours of the bands were of great value in making vibrational assignments. In fact the intensity contours of Raman bands of gases are probably better criteria for such assignments than the frequently used depolarization factors. Another example is the spectrum of carbon disulphide  $\text{CS}_2$  where the sharp Q branches of the Fermi diad  $\nu_1, 2\nu_2$  were observed as well as those of nine "hot" bands. These data have led to an evaluation of the effects of Fermi resonance and to the determination of a set of vibrational and anharmonic constants for  $\text{CS}_2$ .

For those bands where rotational structure was observed, the vibrational assignments were

unambiguous and the analyses gave band origins and rotational constants. For some bands, particularly in methane and ethane, the analyses also gave values of the Coriolis coupling constants.

The investigation of the ethane spectrum, by Romanko, Feldman and Welsh<sup>19</sup> appears to have solved the long outstanding problem of the equilibrium configuration of ethane. The problem is to determine whether ethane has the eclipsed configuration (point group  $D_{3h}$ ) or the staggered configuration (point group  $D_{3d}$ ). An unequivocal decision can be made if the rotational structure in the Raman spectrum of any one of the doubly degenerate bands  $\nu_{10}$ ,  $\nu_{11}$  or  $\nu_{12}$  is resolved: For the eclipsed model the selection rules for the quantum number  $K$  are  $\Delta K = \pm 1$ , while for the staggered model  $\Delta K = \pm 1, \pm 2$ . The band  $\nu_{12}$  has not been observed, and  $\nu_{11}$  has complications due to Coriolis interactions. However, the band  $\nu_{10}$  consists of a series of widely spaced lines which are definitely shown to be due to transitions  $\Delta K = \pm 2$  and this result establishes the staggered configuration ( $D_{3d}$ ) for ethane.

The  $\nu_2$  and  $\nu_3$  Raman and infrared bands of methane are seriously complicated by Coriolis interactions. The Raman spectra have yielded considerably more detail than the infrared spectra and some success in analysing them has been achieved. Values of band origins and rotational constants have been obtained but of more importance is the fact that the Raman results have to some extent helped in the analysis and understanding of some of the complex features in the infrared spectra. In the triply degenerate vibrational level,  $\nu_3$ , Coriolis coupling splits each rotational level into three. The Raman selection rules are  $\Delta J = 0, \pm 1, \pm 2$  for transitions to each of the three rotational levels and therefore 15 branches are predicted, and all have been observed. The infrared selection rules are  $\Delta J = 0, \pm 1$ , but the transitions are restricted so that only three branches without a common upper level are predicted. These three branches have been observed many times but always accompanied by a series of weak lines which have not been explained. When the frequencies of these extra lines were compared with the Raman frequencies many coincidences were found. There seems to be no doubt that the lines belong to the  $\nu_3$  band and that the restricted infrared selection rules are not valid. Similarly, the Raman spectrum of the doubly

degenerate  $\nu_2$  vibration<sup>23</sup> shows that Coriolis interaction with the nearby level  $\nu_4$  splits the rotational levels of  $\nu_2$  into two sets. Transitions with  $\Delta J = 0, \pm 1$  terminate in one set and transitions with  $\Delta J = \pm 2$  terminate in the other. From this analysis it was found that the doublet pattern of the infrared spectrum arises from transitions  $\Delta J = 0, \pm 1$  to each set of upper levels. Detailed theoretical explanations of these features in the  $\nu_2$  and  $\nu_3$  bands of methane have not yet been given.

These investigations have shown that valuable information of molecular structures can be obtained from the Raman spectra of gases photographed at high resolution. One may confidently expect that further work in this field will lead to other important results and to a more complete understanding of molecular spectra and molecular structures.

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# THE INDIAN ACADEMY OF SCIENCES

At the invitation of Sri Venkateswara University, the Indian Academy of Sciences met at Tirupati on the 28th, the 29th and the 30th of December 1957, under the Presidency of Professor Sir C. V. Raman, F.R.S., N.L. Two symposia were held, one on "Geophysics" and the other on "Rice". The former is of special topical interest and the latter a vital subject in view of the existing food situation in India.

In his Presidential Address, Professor C. V. Raman outlined a new approach to the interpretation of the chemical behaviour of carbon. The quadrivalency of carbon and the equivalence of its four valences compel us to recognize that the quartet of valence electrons assumes a configuration exhibiting tetrahedral symmetry. The four axes of the tetrahedron have to be identified with the axes of the orbital angular momentum of each of the four electrons. The four orbits have to be similar and hence have to be described in the same sense. We have, therefore, two possible distinct states of the carbon atom, from which again, the existence of two distinct types of diamond exhibiting respectively tetrahedral and octahedral symmetry of structure follows as a natural consequence.

The Symposium on Geophysics was opened by Dr. S. Bhagavantam who spoke on the earth's crust. He indicated how the measurements of sound wave velocities reveal the structure of the interior of the earth. He further discussed the behaviour of rocks at high pressures as existing in the interior of the earth and suggested a plausible mechanism of earthquakes and rock-bursts wherein an enormous amount of deformation energy is released when a shearing stress acts on highly compressed rocks and how this can be understood from the third-order elasticity theory.

Dr. G. N. Ramachandran spoke on the theory of gravitation. He indicated in his talk how, by starting from the special theory of relativity as a basis and introducing a term in the equations of motion of a particle dependent on its velocity transverse to the direction of the field, it is possible to derive with certain modifications, the principal consequences of Einstein's gravitation theory, viz., the precession of the orbit of the planet Mercury, the deflection of light in a gravitational field and the red shift of the spectral frequencies.

Dr. K. R. Ramanathan, President of the Xith General Assembly of the International Union of Geodesy and Geophysics for the Toronto Meeting, in his speech covered a wide field of activity. He referred to several important aspects of the physics of the earth. He discussed seismology, earth's magnetism and radioactivity with reference to heat flow from the earth and the earth's atmosphere. Under the upper air phenomena he dealt at length with auroræ, ionosphere and ionospheric disturbances and whistlers.

Dr. Vikram Sarabhai spoke on the solar and terrestrial relationships confining himself mainly to the dependence of cosmic ray intensity on the solar activity.

Dr. Rode spoke on the "Evolution of Southern Oceans".

Professor B. S. Madhava Rao gave a survey of the important applications of the Lorentz group in physical problems, especially in the field of elementary particles. He dealt at length with the recent work of Lee and Yang on the non-conservation of parity laws in the so-called weak interactions and its impact on several of the conservation laws of physics.

Dr. M. V. Govindaswamy spoke on "Research in Mental Disorders in India".

The Symposium on Rice was opened by Dr. K. Ramiah who outlined the problems and means of increasing production of rice, the chief methods available to increase acre yield being (i) improvement of water facilities, (ii) improvement of varieties by breeding, (iii) improvement of the natural fertility of the soil, (iv) improvement of cultivation practices, and (v) prevention of losses due to pests and diseases. He was followed by a number of other speakers who dealt at length with the different aspects of improvement of rice varieties by breeding with special reference to crosses, soil fertility and soil improvement by application of manures and fertilisers and methods of eliminating paddy pests by careful use of insecticides and fungicides, etc., etc.

Other papers of physical and chemical interest were read and discussed. Two popular lectures were delivered, one on "The Nature of Cells", by Dr. B. R. Seshachar and another on "The Raman Effect", by Dr. S. Bhagavan-tam.

## SOME RECENT SOVIET WORK ON CRYSTAL PHYSICS

R. F. S. HEARMON\*

**D**URING recent years, the volume of published Soviet work in physics has increased considerably. The established journals have tended to become larger, and several new journals have appeared. An appreciable fraction of this output has been devoted to various aspects of crystal physics, and this article summarizes some of the work. X-ray and electron diffraction investigations are excluded, as is also much of the work on barium titanate and allied piezoceramics; a review of early investigations on the latter subject was given by Hausner,<sup>1</sup> and more recent work has been dealt with by Smolenskiĭ,<sup>2</sup> who has correlated the Russian results with those of workers in other countries.

The majority of references given at the end are to work published after 1952-53; a review of earlier Soviet work on crystallography, including crystal physics, has been given by Mackay.<sup>3</sup>

## ELECTICAL AND MAGNETIC PROPERTIES

Zheludev<sup>4</sup> has dealt with the fundamentals of the dielectric properties of crystals, including their representation by ellipsoids, together with the associated radius normal property. Electric strength has also been considered<sup>5</sup> experimentally in relation to crystallographic orientation, and theoretically in relation to mechanical and thermal stability and the lattice energy. Experimental results have also been given for the temperature dependence of dielectric constant in NaCl<sup>6</sup>; for dielectric losses in alkali halides as affected by frequency and temperature,<sup>7</sup> and for the dependence of electrical conductivity in quartz on temperature and on the electric and magnetic fields.<sup>8</sup> Work on magnetism has included the theory of magnetic symmetry<sup>9</sup>; magnetostriction in nickel<sup>10</sup>; and the anisotropy of magnetic properties in zinc single crystals.<sup>11</sup>

## PIEZOELECTRIC AND FERROELECTRIC PHENOMENA

In 1955, a conference on piezoelectricity was held in Moscow, and the papers presented, numbering 15 altogether, were published early in 1956.<sup>12</sup> The papers dealt with: barium titanate and other piezoceramics; new piezoelectric crystals; piezoelectric properties of wood and cellulose materials; physical properties and domain structure of Rochelle salt, including the effect of impurities and exposure to

gamma radiation; the theory of piezoelectric resonators and the use of defective crystals for the production of oscillator plates.<sup>13</sup> Methods have been investigated<sup>14</sup> for growing crystals of ethylene diamine tartrate, lithium sulphate and potassium tartrate; and instruments described<sup>15</sup> utilising piezoelectric crystals for measuring the pressure of explosions in gaseous mixtures and the stresses in intermittently acting mechanisms. In addition to the work on wood mentioned above, studies have been made of the piezoelectric effect in rocks.<sup>16</sup> Electrets in carnauba wax, and photoelectrets in sulphur single crystal have also been investigated.<sup>17</sup>

The properties of Rochelle salt and other ferroelectric materials have received much attention. In strong 50 c/s. fields it appears<sup>18</sup> that ferroelectric properties in Rochelle salt persist above 24°C., normally taken as the upper Curie point. The index of refraction shows no discontinuity at the upper Curie point,<sup>19</sup> and on exposure to gamma rays from Co 60, the ferroelectric behaviour becomes less marked and ultimately disappears.<sup>20</sup> The effect of impurities on dielectric constant, piezoelectric modulus, crystal habit and domain structure have been studied.<sup>21</sup> Zheludev and Shuvailov<sup>22</sup> list the crystal symmetries of possible ferroelectric phases corresponding with a given symmetry and direction in the initial phase. The domain structure of Rochelle salt has been examined optically, and by a technique involving micro-cinematography.<sup>24</sup> The latter technique has also been used to follow phase transitions and domain structure in barium titanate<sup>25</sup> and the behaviour of spiral centres and dislocations during crystal growth.<sup>26</sup>

## ELASTIC AND ALLIED PROPERTIES

Values of the elastic constants of  $\alpha$ - and  $\beta$ -quartz, NaCl, AgCl and ammonium dihydrogen phosphate (ADP) have been published, and, except for ADP, the variation with temperature is also given.<sup>27</sup> Three different techniques were involved: a composite oscillator was used for NaCl and AgCl; the Schaefer-Bergmann method for  $\alpha$ - and  $\beta$ -quartz; and for ADP, the method involved comparing the transmission velocity through the material with that through a known liquid.

Zubov and Firsova<sup>28</sup> have reported measurements on quartz at 20°C., obtained by the Schaefer-Bergmann method. They observed some inconsistencies in the results which they

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interpret as supporting the theory of Laval and Raman-Viswanathan, according to which the number of independent elastic constants needed to specify the behaviour of a completely asymmetric material is 45, instead of the 21 required according to the classical theory of Voigt; in quartz, the corresponding numbers are 10 and 6.

Aleksandrov<sup>29</sup> has dealt theoretically and experimentally with the analogy between the propagation of ultrasonic waves and light in crystals; various aspects of this analogy had previously been brought out by other workers. For an arbitrary direction of wave propagation in an anisotropic material, there are three independent waves, the displacement directions in each being mutually perpendicular. In general, these directions are neither coincident with, nor perpendicular to the direction of propagation, and the vibrations are therefore quasi-longitudinal or quasi-transverse. In certain special directions, however, the waves are purely longitudinal and purely transverse, and, following Borgnis, Aleksandrov has worked out the special directions for a material of orthorhombic symmetry, and from these results has deduced the special directions in tetragonal, hexagonal, and cubic materials. Aleksandrov has demonstrated experimentally the existence of polarisation effects with ultrasonic waves, and has discussed the possibility of double refraction and internal conical refraction. All these effects have, in fact, been observed previously, but another effect mentioned by Aleksandrov, the possibility of using a quarter wave plate of quartz to produce circularly polarised vibrations, has not.

Some of the recent work has dealt theoretically with thermal stresses in anisotropic bodies belonging to different crystal classes,<sup>30</sup> and with the fundamentals of the strength of anisotropic materials.<sup>31</sup> The formation and structure of "kink-bands", and their relationship to crystal orientation and state of stress in ionic crystals have been investigated<sup>32</sup>; the application of photoelastic methods to the study of stress distribution in anisotropic systems has also been suggested.<sup>33</sup>

#### THERMAL PROPERTIES

Values of the thermal expansion coefficients as measured by X-ray methods have been re-reported<sup>34</sup>; theoretical analyses have been made of problems in thermal expansion and conduction<sup>35</sup>; and relationships between the expansion and conduction coefficients have been examined.<sup>36</sup> Shubnikov<sup>37</sup> has discussed some fundamental points connected with the thermal ex-

pansion of crystals; he has emphasised the importance of the thermal shear deformation which occurs in many crystal classes and has illustrated diagrammatically the thermal deformation surfaces corresponding with different relative values of the principal thermal expansion coefficients of single crystals.

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(1) Dokl. Akad. Nauk SSSR. (2) D. (3) Soviet Physics-Doklady. (4) American Institute of Physics.

(1) Zh. éksp. teor. Fiz. (2) E. (3) Soviet Physics-JETP. (4) American Institute of Physics.

(1) Izv. Akad. Nauk SSSR. Ser. Fiz. (2) I. (3) Bulletin of the Academy of Sciences, USSR, Physics Series. (4) Columbia Technical Translations.

(1) Kristallografiya. (2) K. (3) and (4) Not translated.

(1) Zh. tekhn. Fiz. (2) T. (3) Soviet Physics-Technical Physics. (4) American Institute of Physics.

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## LIGHTNING SHOCK

**A** DIRECT HIT by a lightning flash or a high-voltage electric current is almost invariably fatal. Massive holes and tears are found in the body, especially in the brain and blood vessels. But most people apparently struck by lightning seem to suffer no more than freakish damage to parts of their clothes and body. This is because the current tends to take the pathway of lowest resistance; it leaps from one low resistance conductor to another, so that down this pathway all the energy is dissipated, leaving organs a few centimetres away unharmed. The main resistance offered by the body is in the dry skin, and that is why household electric currents are so much more dangerous to the wet body. Surprisingly, the pathways followed by such currents as do traverse the body are not yet finally settled. It is thought that the energy goes mainly along blood vessels or nerves and it is considered that the whole body is a low resistance, structureless gel, so that there is a steady potential drop along the shortest line between the points of entry and exit of the current, with uniform potential fields around. When the current passes from one hand to the other it traverses the lower cervical spinal cord, which may explain why the results of this accident often took like transverse myelitis or even disseminated sclerosis. Whatever the pathways taken, it is

the nervous system that always seems to bear the brunt of the current, though experimentally large currents can make the heart stop or fibrillate. A condition of profound "shock" with apparent suppression of all nervous activity may last one or two hours after a heavy electrical shock, yet the persons still recover without apparent sequelae.

The changes seen in the body after an electric shock depend in the first place and most importantly on the physical characteristics of the current applied, especially on voltage. Of secondary importance is the pathway of the current—its points of entry and exit—and how great a potential gradient is produced inside the body once the high resistance of the skin has been broken down. The brain seems to be the most sensitive organ, but its functions are more often temporarily suspended than destroyed or permanently modified. For this reason it has always been recommended that prolonged artificial respiration be given to those apparently dead from electric shock or lightning. However, a careful physical examination is also necessary, since other potentially fatal lesions such as skull fractures may result from the patient being hurled on to the ground or on to other hard objects by the force of the current. (*B.M.J.*, Nov. 16, 1957.)

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## ELEVENTH GENERAL ASSEMBLY OF INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS

THE Eleventh General Assembly of the International Union of Geodesy and Geophysics which was held in Toronto, Canada, during September 3-14, 1957, is of particular interest to India as, for the first time in the history of the Union, it had elected to its Presidency a distinguished scientist of India—Professor K. R. Ramanathan, Director of the Physical Research Laboratories, Ahmedabad. Besides, the Toronto Assembly was held during the International Geophysical Year in which several Indian organizations are participating.

The Assembly, in which about 1,500 delegates from 50 countries participated, was formally inaugurated on September 3rd, by Mr. John Diefenbaker, Prime Minister of Canada. Professor Ramanathan, in his Presidential Address, reviewed the progress of the Union during 1954-57, and summarized recent trends in geophysical research in the fields of Geomagnetism, Atmospheric Physics, Cosmic Rays and Solar Activity.

The Constituent Associations of the Union held their sessions during September 4-13. The Association of Seismology and the Physics of the Interior of the Earth, under the Chairmanship of Prof. K. E. Bullen, organized discussions and symposia in the following subjects: Earthquake Magnitude and Energy, Crustal Structure of Continents and Ocean Basins, Travel Times and Velocities of Earthquake Waves and the Internal Structure of the Earth, Conditions at the Foci of Earthquakes with Special Reference to Fault Planes and Seismic Studies in the Arctic and Antarctic. The participants included many eminent scientists including Professors Gutenberg, Press and Birch of U.S.A., Jeffreys and Bullard of U.K., Belousov of U.S.S.R., Tsuboi of Japan and Tuzo Wilson of Canada. The proposal of Prof. Bullen to request the Nuclear Powers to detonate a few A-Bombs at appropriate places and pre-arranged times so as to help the study of the earth's interior was strongly opposed by the Russian delegation on the ground that "it is not necessary (for this purpose) to do such a thing as exploding the Bombs". Dr. Vladimir Belousov, Chief of the Department of Geodynamics, Institute of the Physics of the Earth, Moscow, who made the statement believes that improvement in the precision of the techniques currently employed will be equally effective.

The highlights of the proceedings of the Association of Volcanology were the Presidential Address of Prof. A. Rittman of Switzerland

on magma, crust and substratum and the symposium on Geochronology and Radioactivity organized jointly with the Association of Seismology, in which prominent research workers in Geochronology from all over the world participated.

Professor Rossby of Sweden was scheduled to preside over the Sessions of the Association of Meteorology but unfortunately he passed away shortly before the Conference. The proceedings were conducted by Dr. J. M. van Mieghem. There were well-attended symposia on "Numerical and Graphical Methods of Dynamical Weather Prediction", on "Atmospheric Turbulence", "Atmospheric Chemistry and Air Pollution", "Meso-meteorology", "Atmospheric Ozone and Related Problems of the Upper Atmosphere", and "Atmospheric Electricity". The last two were organised jointly with the Association of Geomagnetism and Aeronomy.

The Association of Geomagnetism and Aeronomy conducted its proceedings under the Chairmanship of Professor J. Bartels of Germany. A comprehensive and a very successful three-day symposium on Aeronomy and Solar-Terrestrial relationships was arranged by Prof. J. Kaplan. There was also an excellent symposium on "Secular Variation and Paleomagnetism" organised by Prof. Bullard. Paleomagnetic results from India, and especially data relating to the Deccan traps, were discussed by Mr. J. A. Cragg and E. R. Deutsch.

The Association of Physical Oceanography met under the Chairmanship of Professor H. Mosby of Norway. Symposia were arranged on the following topics: Water Balance (jointly with the Associations of Meteorology and Hydrology), General Circulation of the Ocean with Particular Emphasis on Deep Water Movements, Construction of Cotidal Charts, Carbon dioxide Cycle in the Atmosphere and Ocean, Currents and Tidal Streams near the Bottom in Coastal Waters and Estuaries, and Transfer of Momentum from the Air to the Sea. Papers on Physical Oceanographic Studies in the Bay of Bengal, Arabian Sea and Indian Ocean were submitted by Drs. La Fond, Nanda, Ramanadham, and Balaramamurthy, Drs. Doodson and Revelle presided over some of the Sessions of the Association.

Professor J. T. Thijsse of Netherlands gave the Presidential Address to the Association of Scientific Hydrology. Discussions were held

on Problems of Ice and Snow, Subterranean Waters and Continental Erosion.

Two well-attended public lectures on the following topics were organized in connection with the I.U.G.G. Conference: "The Arctic and Antarctic Program of the I.G.Y.", by Dr. E. I. Tolstikov, Deputy Chief of the Northern Sea-Route Administrations of U.S.S.R., and "The Earth Satellites", by Prof. L. V. Berkner, President of the International Council of Scientific Unions.

The generous Canadian hosts had worked out an excellent programme of visits and entertainments, designed to acquaint the visiting scientists with the natural beauty spots around Toronto.

The Toronto Assembly of the I.U.G.G. con-

cluded its deliberations on September 14th. Dedicating itself, in the words of President Ramanathan, to *Sathyam* (Truth), *Jnānam* (Knowledge), *Anantham* (Without end). It was officially announced that Professor J. T. Wilson of Canada had been elected as the next President. The Twelfth General Assembly will be held in Helsinki, Finland, in 1960.

The Indian delegation was composed of Prof. K. R. Ramanathan, Director, Physical Research Laboratory, Ahmedabad, and Dr. U. Aswathanarayana, Andhra University, Waltair. The following Indian Research Fellows working in Canada joined as guests: Drs. S. C. Das, R. Pratap, M. V. N. Murthy, A. K. Saha and Mr. Agarwal.

U. ASWATHANARAYANA.

### PREPARATION OF NOBELIUM

**T**HE new element was synthesized by the fusion of an atom of the heavy isotope of carbon, carbon-13, with an atom of curium (element 96). In order to obtain the most stable product, it was necessary to use the heaviest available isotope of curium. This is curium-244, and it was only available in the United States as a product of irradiating plutonium with neutrons in the world's highest flux reactor.

Great Britain provided considerable quantities of carbon-13 required, from Harwell and the Nobel Institute of Physics, Stockholm, provided the Cyclotron, the only one in the world capable of accelerating carbon ions with the required energy and intensity.

Due to the hazardous nature of the target material and the difficulty of separating a few atoms of the new element from it, a rather new bombardment technique was employed. This utilized the recoil or 'knock-on' effect. A thin layer of curium was deposited on an aluminium foil, and the product atoms knocked out of the target were collected in a plastic film after passing through a very thin aluminium cover foil placed over the curium target, to prevent the spread of curium contamination. The plastic film was ignited on a platinum disk to recover the product atoms. The decay of these atoms could be observed directly, or they could be dissolved off the plate for chemical identification.

A new alpha-activity of 8.5 MeV. energy was

observed among the products, and although only seventeen events of this energy were observed with certainty, it was possible to show that the new alpha-emitter had the expected chemical properties for an isotope of element 102. The chemical experiments in each case used ion-exchange techniques. When the activity was absorbed on a column of cation-exchange resin and washed off with a complexing agent (alpha-hydroxy isobutyric acid), the 8.5 MeV. alpha-activity appeared in the drops predicted for element 102.

There was a possibility that the activity might be due to thorium-225, which has a half-life of 8 min. and produces a short-lived daughter, polonium-213, which emits 8.4 MeV. alpha-particles. This was eliminated by eluting the activity from a cation-exchange column with 6N hydrochloric acid. Under these conditions, thorium is retained by the column, while the trivalent actinide elements are eluted rapidly. The 8.5 MeV. alpha-activity was found in the actinide fraction.

A graph showing the moment of decay of each of the seventeen atoms observed gave a half-life of about 10 min. for the new activity. The observed alpha-particle energy and half-life, the absence of spontaneous fission, and the method of preparation lead us to believe that the mass number of the isotope prepared is either 251 or 253, the latter number being more likely (*Nature*, Nov. 16, 1957.)



## A PRELIMINARY REPORT ON THE DETECTION OF ISOPROPYL-NORADRENALINE IN HUMAN URINE

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MARY F. LOCKETT (1954)<sup>1</sup> reported for the first time that a new sympathomimetic amine was unexpectedly encountered in an experiment in which adrenaline and noradrenaline were being separated chromatographically from the adrenal gland of cat. According to her the third amine is isopropyl-noradrenaline and it is found to be present in the adrenal glands of cat, monkey and man.

Garb *et al.* (1956)<sup>2</sup> commented that its discovery in the adrenal gland may be significant because of its high potency and it may be very useful in the management of cardiac arrest on account of its unique property of increasing the rate of the heart—a manifestation of enhanced automaticity.

The presence of isopropyl-noradrenaline in the urine has not been reported so far in the literature.

**Materials and Methods.**—Out of a total of 800 samples of urine analysed in this laboratory for catechol amines a profound fall of blood pressure was noticed in four cases.

Twenty-four hours samples of urine were collected from normal subjects and patients suffering from hypertension. The catechol amines were extracted by the method of Von Euler and Orwen (1955).<sup>3</sup> Adsorption of the catechol amines on to alumina and extraction with acid by this method usually gives a histamine-free extract. Further care was taken in all these cases to eliminate the fall of blood pressure by this mechanism by administering sufficient doses of antihistaminics prior to the experiments.

The extract was assayed biologically on the blood pressure of the spinal cat and by the effect on the not-denervated nictitating membrane of the same animal. The biological assays were carried out on three different cats with the same sample as well as by samples collected on different days.

The results were verified by paper chromatography using a modified method of Vogt (1952).<sup>4</sup> The solvent for the chromatogram was phenol containing 15% V/W 0.1N hydrochloric acid and ascending chromatograms were run for 16 hours. By that time the solvent front invariably advanced to about 14" from the starting line. The spraying agent for oxidation of amines was 2% aqueous solution of

potassium iodate instead of potassium ferricyanide as used by Vogt. Chromatograms of three samples of urine and a reference mixture containing known concentrations of noradrenaline, adrenaline and isopropyl-noradrenaline (Isoprenaline-Boots) were made in parallel on a single sheet of paper. Quantitatively the amines from the developed chromatogram were estimated by the densitometer as well as by the effects of the extracts of the chromatograms by the biological methods. One sample was used for the determination of  $R_f$  values, the second for biological assay and the third for quantitative determination by the densitometer.

The identity of the third amine was also confirmed by the action of the urinary concentrate as well as of the chromatogram extract on the auricles of the cat and the isolated uterus of the virgin white rat. All the four samples of urine were from men, three of them having normal blood pressure. The other one was suffering from essential hypertension. The ages were 35, 36, 43 and 52 years and the blood pressure was 118/78, 115/80, 120/80 and 180/100 mm. of mercury respectively.

**Results.**—The urinary concentrate as well as the chromatogram extract gave the following results:

1. Both produced a profound fall in blood pressure with tachycardia in the spinal cat (Fig. 1).
2. Even after massive doses of anthesisan intravenously the extracts produced the characteristic fall in blood pressure whereas an equivalent dose of histamine was without any effect (Fig. 2).
3. There was no contraction of the nictitating membrane of the cat (Fig. 1).
4. On the auricle of the cat, the extracts produced marked increase in the rate and amplitude of the contractions (Fig. 3).
5. The uterine contractions of the rat were promptly inhibited by the test solutions. The action was similar to that of adrenaline (Fig. 4).
6. On the paper the third amine appeared as a pale pink spot, exactly like isopropyl-noradrenaline. The  $R_f$  value varied between .69 to .71 in the four different samples. This spot was distinct from noradrenaline, adrenaline and hydroxy-tyramine (Fig. 5).

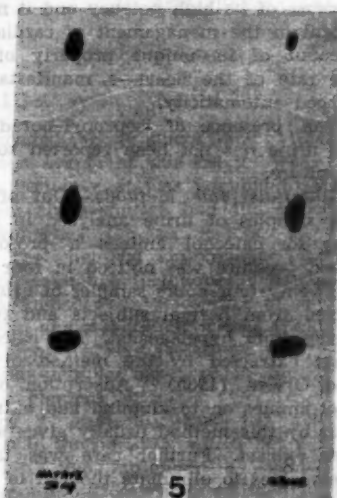
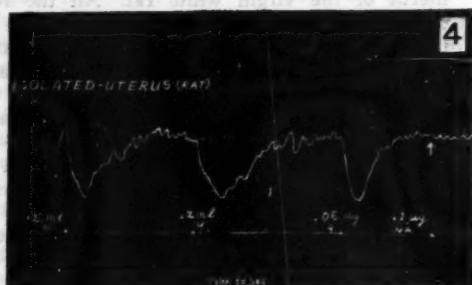
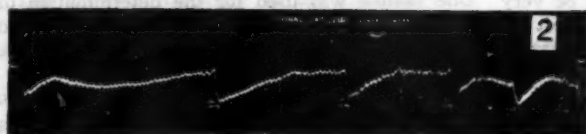
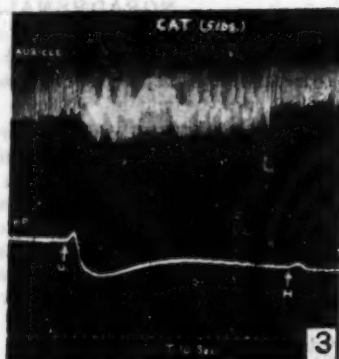
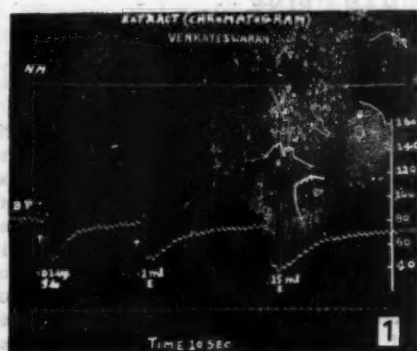


FIG. 1. Spinal cat. Effect of extract of chromatogram on nictitating membrane and blood pressure. 1.  $\cdot 01$  mcg. isoprenaline. 2.  $\cdot 1$  ml. extract. 3.  $\cdot 15$  ml. extract. Time 10 seconds.

FIG. 2. Spinal cat. Effect of extract of urine on blood pressure. 1.  $\cdot 2$  ml. urine. 2.  $\cdot 05$  mcg. isoprenaline. 3.  $\cdot 5$  mg. histamine. 4.  $\cdot 5$  mg. anthisan. 5.  $\cdot 1$  ml. urine. 6.  $\cdot 5$  mg. histamine. Time 10 seconds.

FIG. 3. Spinal cat. Myocardiogram. Contractions of the auricles *in situ* and blood pressure.  $\cdot 5$  mg. of anthisan had been given by intravenous injection prior to the experiments. 1. Extract of urine. 2. Histamine. Time 10 seconds.

FIG. 4. Isolated uterine horn of white rat. 1.  $\cdot 2$  ml. urine extract. 2. Same as 1. 3.  $\cdot 05$  mcg. adrenaline. 4.  $\cdot 1$  mcg. noradrenaline. Time 10 seconds.

FIG. 5. Chromatogram of the extract of urine. 1. Reference mixture containing 10 mcg. each of noradrenaline, adrenaline and isoprenaline. 2. Extract of urine. (The lowest spot is noradrenaline, the middle one adrenaline and the topmost one isopropyl-noradrenaline.)

The amounts of isopropyl-noradrenaline in the four samples were as follows:

	By Biological Method	By Densitometer
1	4.8 micrograms per day	5 micrograms per day
2	6.4 "	6.2 "
3	6.8 "	6.4 "
4	10.2 "	10.6 "

Von Euler (1954)<sup>5</sup> reported a case of pheochromocytoma in which the urinary extract produced a persistent fall of blood pressure in the cat. The reason for this peculiar reaction was not elucidated.

Out of 800 cases analysed in this Laboratory, four samples gave results which were analogous

with those of Von Euler. It is suggested that the fall in blood pressure is due to the presence of isopropyl-noradrenaline in the urine and it has been possible to prove that it is so both by biological assays and chromatography. The metabolism of this catechol amine and its rarity in urine specimens require further study.

My thanks are due to Dr. K. Madhavan Kutty

and Mr. C. P. Chamukuttan for the kind help rendered.

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## ACCIDENT AT WINDSCALE

**A** REPORT on the accident at Windscale, published as a White Paper, shows that no harm to anyone's health is to be expected, though it points to certain shortcomings in the organization. An operation for the controlled release of Wigner energy, which is a routine procedure in uranium-graphite piles, was being carried out at the time the accident occurred. A standard pile consists of a large block of graphite somewhat larger than a house, with hundreds of cylindrical holes passing from one side to the other, parallel to the ground. Cartridges composed of uranium and uranium oxide contained in a case of aluminium zirconium alloy are inserted into the centre of the pile through the holes at one side, and, when expended, are pushed out from the other by fresh cartridges similarly inserted. The surrounding graphite is known as the moderator and slows down the neutrons emitted from the uranium to a suitable level. This results in some of the atoms of carbon becoming displaced from stable to unstable positions, thus increasing the internal energy of the graphite. E. P. Wigner postulated that this would occur, and the phenomenon is progressive and can result in a spontaneous release of energy. This occurred in the Windscale pile in 1952. Artificial heating of the graphite under controlled conditions causes a reversal of the Wigner effect, and this operation, which had been successfully accomplished on eight previous occasions, was in progress when the accident occurred.

Controlled release of stored Wigner energy is accomplished by shutting off the air-cooling systems which are normally in operation and allowing the temperature of pile to rise. The progress of the operation is assessed by observation of the temperatures which are recorded by thermocouples, but on this occasion, owing partly to lack of adequate knowledge of the Wigner effect at the time the pile was built, unduly high temperatures were being attained at points in the graphite where thermo-

couples were not installed. The physicist in charge of the operation, handicapped by insufficient data and inadequate instructions for the procedure, repeated the heating process too soon and too quickly, causing failure of the uranium cartridges and oxidation of the uranium. On October 9, it was realized that the graphite temperature readings were unusually high, and the cooler fans were turned on intermittently. Early on the next day meters in the chimney recorded increased radioactivity, but the levels were considered to be within normal limits. The fans were turned on again and again but the measured radioactivity increased. As a result of these observations, the operators concluded that one or more uranium cartridges had failed. Special apparatus is installed to assist in the detection of burst cartridges, but on this occasion the scanning gear was found to be jammed, although it had been recently repaired. It was necessary therefore to arrange for visual inspection through the pile face, and four channels revealed cartridges at red heat. Because the cartridges were distorted by the heat it was not possible to eject them in the normal way through the opposite face of the graphite pile, and the fire was therefore localized by removing a number of neighbouring cartridges. Carbon dioxide foam was applied but failed to reduce the temperature, and it was decided then to use water to quench the fire. This was begun at 8-55 a.m. on October 11, 1957, adequate measures having been taken to ensure the safety of the staff, and continued for 24 hours, at the end of which time the pile was cold. Although the Committee of Inquiry was unable to endorse the conclusion that the observed temperature recordings indicated the need for a second heating, it agreed that both the instrumentation in the pile and the instructions to the physicists were inadequate. The Atomic Energy Authority has accepted full responsibility for the accident and is determined to do all it can to avoid a similar occurrence elsewhere. (*B.M.J.*, Nov. 16, 1957.)

## LETTERS TO THE EDITOR

ANODIC REACTIONS IN THE  
ELECTROLYSIS OF ACID-COBALT-  
FLUORIDE

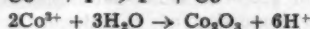
OF the various cations which lend themselves to oxidation anodically, a few like silver and lead form solid, insoluble, electrically conducting products on the anode. Cobalt has also been reported to form a hydrated cobaltic oxide anodically, in the electrolysis of slightly alkaline or slightly acid solutions of its salts.<sup>1-4</sup> It has been stated that the composition of the oxide conforms to  $\text{Co}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$  when deposited in thin layers and  $\text{Co}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$  when deposited in thick layers.<sup>3</sup>

The authors felt interested in the anodic reactions in the electrolysis of cobalt fluoride, following the discovery of the anodic formation of a higher oxide of silver,  $\text{AgO}_2$ , in the electrolysis of silver fluoride.<sup>5</sup> Skirrow<sup>2</sup> found only  $\text{Co}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$  in the electrolysis of cobaltic salts containing some hydrofluoric acid. Barbieri and Calzolari,<sup>6</sup> electrolyzing cobaltous fluoride dissolved in a 40% solution of hydrofluoric acid found a green anodic deposit of  $\text{CoF}_3 \cdot n\text{H}_2\text{O}$ . The hydrated cobaltic oxide prepared by earlier workers has always been described as black and crystalline. In confirmation of the findings of previous workers, the present authors have found that in the electrolysis of fluoride solutions also, the presence of too much of free acid is not favourable for the formation of cobaltic oxide. In a solution composed of 0.1216 M.  $\text{CoF}_2$  and 0.6224 M. HF, a mixture that was found suitable and stable for continuous electrolysis for the electrodeposition of cobalt, the anodic product was obtained in reasonable quantities. With lesser quantities of acid, current efficiency was higher and with a ratio of  $\text{CoF}_2/\text{HF}$  more than 10, no deposit was obtained.

Careful analysis of the black deposit for its water content, loss of weight on strong heating, determination of available oxygen and percentage of cobalt in the compound, prepared in almost neutral solutions and in acidic solutions, showed it to be  $\text{Co}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$ . Even when thick deposits were obtained, we found no evidence for the formation of trihydrate reported by Cohen and Glaser.

The anodic reaction carried out under a variety of conditions does not appear, even in the electrolysis of fluoride, to go beyond oxidising cobalt to tervalent stage. The anode

discharge potentials in nearly neutral fluoride solutions in the bath mentioned above and in acid solutions in which  $\text{CoF}_2/\text{HF}$  exceeds 10, have been found to be 1.2 volt, 1.45 volt and 1.72 volt respectively. The authors have found that the anode discharge potentials in most of the metallic fluoride solutions happen to be in the neighbourhood of 1.72 volt and oxygen is invariably the product. In the cases of silver and cobalt, however, the discharge potentials are less (1.4-1.5) and this appears to favour the oxidation of these cations. When higher anode potentials are reached, however, oxygen evolution results. The following mechanism is suggested for the formation of cobaltic oxide at the anode.



(heterogeneously on anode)

College of Science, Nagpur, A. N. KAPPANNA.  
and E. R. TALATY.

Central Salt Res. Inst.,  
Bhavnagar, November 1, 1957.

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A COMPENSATED MOVING  
CYLINDER VISCOMETER

THE falling cylinder viscometer designed by Lawaczeck<sup>1</sup> and used by Bridgman,<sup>2</sup> Dow,<sup>3</sup> Awbery and Griffiths<sup>4</sup> in the determination of viscosities of liquids is based on the principle of a cylindrical metal bulb falling in the liquid coaxially in a vertical tube of only slightly greater diameter. The time of the fall  $t$  for a fixed distance  $s$  under uniform velocity is given by the relation

$$\eta = k \frac{t}{s} (\sigma - \rho) g \quad (1)$$

The determination of the viscosity  $\eta$  obviously involved the observation of the actual movement of the bulb in addition to the measurement of the densities  $\sigma$  and  $\rho$  of the bulb and liquid respectively.

We have effected a modification in the method and designed a viscometer in which the only



measurement to be made is the time taken by the cylinder to move a definite distance, the necessity of observing the movement of the cylinder itself not arising. The instrument consists of two exactly similar light solid cylinders or cylindrical bulbs A and B (Fig. 1)

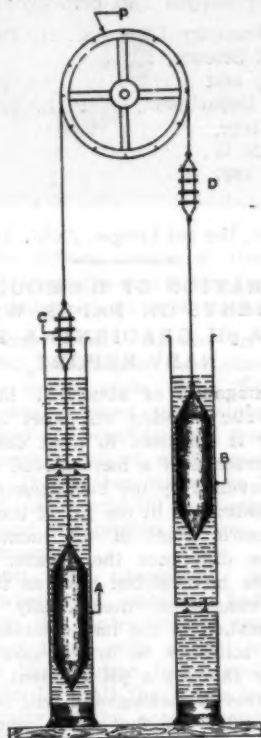


FIG. 1

moving in similar tubes of slightly larger diameter containing the liquid at the same temperature. The conical ends of each cylinder ensure its coaxial movement in the tube. The flexible nylon fibre—nylon fibre does not get wetted by ordinary liquids—connecting A and B passes over a light, almost frictionless pulley. C and D are light-weight carriers of identical shape and mass having holes into which riders of equal mass  $m$  may be inserted. The dimensions of the instrument are given in Table II.

When  $n$  riders are placed on one side, the connected system moves with uniform speed and it can be shown that the time taken ( $T$ ) to move a definite distance  $S$ , viz., that for one revolution of the pulley is given by

$$nmg - F = R \frac{\eta}{T} \quad (2)$$

where  $F$  is the slight friction of the pulley and  $R$  is an instrument constant.

This result may be used to compare the viscosities  $\eta_1$  and  $\eta_2$  of two liquids using the same number of riders and noting the times  $T_1$  and  $T_2$  respectively for a complete rotation of the pulley. Since the slight friction  $F$  remains practically constant, it follows from the equation (2) that

$$\frac{\eta_2}{\eta_1} = \frac{T_2}{T_1} \quad (3)$$

To test the usefulness and accuracy of the instrument, viscosities of mixtures of glycerine and water of different concentrations are compared with the viscosity of water. The results given in Table I show exact agreement with corresponding results obtained using an Ostwald's viscometer.

TABLE I

Viscosity of mixture $\eta_2$		Density of mixture $\rho_2$	
Viscosity of water $\eta_1$		Density of water $\rho_1 = 0.9974$	
Mixture No.	Density of mixture $\rho_2$	Moving Cylinder Viscometer	Ostwald's Viscometer
		$\frac{\eta_2}{\eta_1} = \frac{T_2}{T_1}$	$\frac{\eta_2}{\eta_1} = \frac{\rho_2 t_2}{\rho_1 t_1}$
I	1.0726	1.229	1.227
II	1.0734	1.403	1.403
III	1.0789	1.489	1.489

Compared with the falling cylinder viscometer, the special features of the new instrument are:

(1) the velocity of steady motion can be easily adjusted to any desired value by choosing the proper number of riders instead of altering the weight of the cylinders. The instrument can hence be used for liquids over a wide range of viscosities.

(2) the densities of the liquid and cylinder have not to be determined.

(3) the apparatus is useful for all kinds of liquids, transparent or opaque, as the actual movement of the cylinders has not to be observed. The rotation of the pulley gives the necessary information.

(4) the observations of time  $T$  may be repeated any number of times for the same number of riders while such repetition is difficult in the original falling cylinder form of the viscometer.

TABLE II

Solid cylinders of ebonite A and B	
overall length	7.54 cm.
Length of cylindrical portion	3.93 cm.
Diameter of cylindrical portion	3.691 cm.
Inner diameter of tubes (brass)	3.772 cm.
Circumference of pulley	26.4 cm.

Complete theory and other details are being published elsewhere.

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C. A. VERGESE.

University College,  
Trivandrum,  
November 12, 1957.

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#### KOSTANECKI-ROBINSON PHENYLACETYLATION OF ORCACEPHENONE AND ORCPROPIOPHENONE

HEILBRON, HEY AND LYTGOE<sup>1</sup> have observed that resacetophenone upon Kostanecki-Robinson phenylacetylation gives exclusively a coumarin whereas respropiophenone under similar conditions gives mainly a coumarin with a small amount of chromone. It was therefore thought of interest to observe the behaviour of oracetophenone and orcpropiophenone upon Kostanecki-Robinson phenylacetylation.

Oracetophenone was phenylacetylated with fused sodium phenylacetate and phenylacetic anhydride when it furnished 7-phenylacetoxy-3-phenyl-4:5-dimethyl coumarin, m.p. 176-177°C. The latter on treatment with 80% sulphuric acid gave the corresponding 7-hydroxycoumarin, m.p. 246-247°C. The constitution of this product was established by its hydrolysis to the corresponding cinnamic acid derivative and was further supported by the synthesis of the corresponding chromone. The latter was prepared by the Claisen condensation of the oracetophenone dimethyl ether with ethylphenylacetate, in presence of sodium, followed by the cyclization and demethylation.

Orcpropiophenone, on the other hand, on phenylacetylation under similar conditions affords 7-hydroxy-3:5-dimethyl-2-benzylchromone, m.p. 248-49°C., and the corresponding 7-phenylacetoxy derivative, m.p. 111-112°C. The latter could be easily converted into the former by means of 80% sulphuric acid. The

structure of the said hydroxy chromone was based on its synthesis through an unambiguous method. It was synthesized by the Claisen condensation of the oracetophenone dimethyl ether with the ethyl phenylacetate followed by the methylation of the sodium salt of the  $\beta$ -diketone, cyclization and demethylation.

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Bombay-1; and  
Chemistry Department, P. L. TRIVEDI,  
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Visnagar, N. G.,  
November 1957.

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#### SEPARATION OF HÆMOGLOBIN COMPONENTS ON PAPER WITH THE AID OF A pH GRADIENT—A PRELIMINARY REPORT

For the diagnosis of abnormal hæmoglobins, electrophoretic mobility on paper in an alkaline buffer is sufficient in most cases to indicate the presence of a hæmoglobin variant, the distance travelled by the hæmoglobin depending upon the difference in the pH of the buffer and the iso-electric point of the hæmoglobin, the greater the difference the greater the movement of the hæmoglobin towards the anode.

It was considered theoretically possible to effect separation of the hæmoglobins by allowing their solutions to travel slowly across a filter-paper showing a pH gradient, so that the various forms of hæmoglobin will become relatively insoluble on the paper where suitable pH exists and thus separate in different places.

pH gradient was provided by soaking a circular filter-paper with M/100 citric acid and 'developing' the paper with M/75 Na<sub>2</sub>HPO<sub>4</sub> from a central wick as devised by Giri *et al.*<sup>1</sup> for separation of amino-acids on a filter-paper circle. As more and more of the alkali flowed into the paper, some distance from the centre in a small width of paper, pH gradient was created as was shown by streaking universal indicator in a line from the centre outwards.

A circle 4 cm. in diameter was drawn at the centre of a Whatman No. 1 circular filter-paper of 13 cm. diameter. The paper was soaked in citric acid solution and blotted between sheets of blotting paper. The hæmoglobin solution was then spotted in a line along portions of the pencil mark with intervals in between the streaks to avoid mixing up of the different solutions. As many as six separate solutions

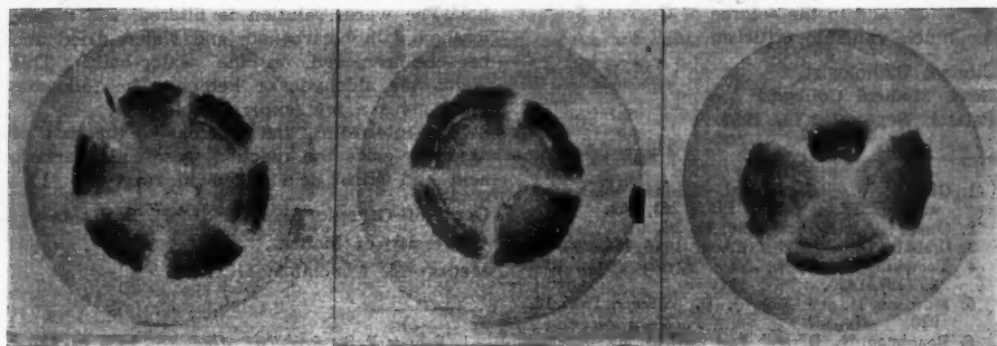


PLATE I. Six different samples of Oxy-Hb solution showing separation into three components.

PLATE II. Haemoglobins from Monkey (top right), Sheep (top left and bottom right), and Man (bottom left).

PLATE III. Met-Hb. (top); Acid Haematin (bottom); Untreated Human Hb (right), and Citric Acid-Hb (left).

could be conveniently spotted on one paper. The  $\text{Na}_2\text{HPO}_4$  solution is then allowed to run in from the central wick. After 15-20 minutes, the paper was removed and stained according to the method of Owen<sup>2</sup> in light green solution, 200 milligrams in 100 ml. of 1% acetic acid for 10 minutes. It was then washed in 2-3 changes of fresh 1% acetic acid till the background was colourless and the protein solution showed up as green layers.

The result was unexpected. After 15-20 minutes, when the solution had travelled 5-6 cm. from the centre, it had separated into three distinct bands with a light trail of protein where the solution had travelled on the paper (Plate I). All the layers were present in the vicinity of the space showing the pH gradient. The optimum time was found to be about 15-20 minutes after which the layers tended to merge into one another, and the optimum concentration 4-5 g. of Hb%. Solutions prepared according to the method of Drabkin,<sup>3</sup> without the use of aluminium chloride or by the lead precipitation method of Tomkins<sup>4</sup> gave identical results. Oxy-Hb, CO-Hb, Foetal Hb and Hbs of monkey, chicken and sheep all gave more or less similar separation (Plate II). Met-Hb did not separate into layers. It moved either as a single band in a very erratic fashion in the form of radial streaks (Plate III). Solutions of acid haematin prepared by adding  $\text{N.HCl}$  to the Hb solutions showed two bands only (Plate III, bottom). Citric acid Hb showed a pattern similar to untreated Hb solution (Plate III, left).

Solutions of different pHs from 4-6.5 were used as soaking solutions keeping the  $\text{Na}_2\text{HPO}_4$

solution constant, and only indifferent separations were seen or mostly none at all. Using  $\text{Na}_2\text{HPO}_4$  for the soak and the citric acid for the run, no separation occurred, the protein moving as a single band. Similar result was obtained if the solutions were prepared in normal saline instead of distilled water.

The nature of the phenomenon is not clear. It appears that Hb as we obtain in solution is not a homogeneous substance, which as it is or as its denatured products, separates into three components under the conditions of the experiment. All the layers, however, showed normal absorption spectra for some minutes after the run. With time the spectra started fading and after about half-an-hour, no absorption bands could be seen. The chances are that separation of the Hb components occurs in their natural state and denaturation occurs sometime later.

Morrison and Cook<sup>5</sup> have reported separation on IRC-50 columns of normal adult Oxy-Hb into three components, showing normal absorption spectra. A similar inhomogeneity was noted by Boardman and Partridge<sup>6</sup> with the sheep and bovine CO-Hbs on the same resin. Morrison and Cook obtained two minor and one major component, whilst with the present method only one minor component is obtained and two others occur in relatively high proportions. At present, it is not possible to explain the difference in the findings. Work on the relative proportion of the components in normal and pathological Hbs is contemplated.

I am indebted to Prof. M. Balasubramanyan for interest and help in the work, to Dr. O. P.

Bagga who kindly drew my attention to some literature, and to the referee of *Current Science* for much valuable criticism.

Clinical Pathologist,  
Govt. Medical College,  
Patiala, September 9, 1957.

N. P. JAIN.

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### OXIDATIVE DECARBOXYLATION OF SOME ALPHA-HYDROXY ACIDS WITH SILVER IODIDE DIBENZOATE

THE use of silver iodide dibenzoate for the scission of alpha-glycols<sup>1</sup> and the conversion of primary aromatic amines to s-azo-compounds<sup>2</sup> has been reported. It has now been found that the complex oxidises alpha-hydroxy acids affording the corresponding aldehydes or ketones in very good yields, with loss of carbon dioxide. The reaction is thus analogous to the action of lead tetraacetate on alpha-hydroxy acids.

The procedure is briefly as follows: To the warm silver iodide dibenzoate complex freshly prepared from silver benzoate (2 moles) and iodine (1 mole) in dry benzene, the dry, powdered, alpha-hydroxy acid (1 mole) is added. Evolution of carbon dioxide starts immediately in most cases and becomes vigorous on warming the mixture. The mixture is then gently

Acid	Carbonyl compound	Yield %	M.P. of 2 : 4-Dinitro-phenyl hydrazone
Mandelic acid	Benzaldehyde	72	236
p-Methoxy mandelic acid	Anisaldehyde	67	252-253
3, 4-Methylenedioxy mandelic acid	Piperonal	76	263-264
Benzilic acid	Benzophenone	83	240
α-Hydroxy-β-phenyl propionic acid	Phenylacetaldehyde	*	118-120

\* In this case much darkening and resinification occurred on heating the mixture. Only a poor yield of the hydrazone was obtained.

refluxed on the water-bath for an hour and a half. The warm solution is filtered, the filtrate washed with bicarbonate and water, dried and benzene removed on the water-bath. This yields the aldehyde or ketone. The following table gives a few experimental data.

It is interesting that whereas in the case of aromatic acids the reaction was facile, tartaric acid and citric acid failed to react.

Dept. of Organic Chem., P. S. RAMAN,  
University of Madras,  
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### A NOTE ON PYROLYSIS AND IGNITION OF WOOD

THE ignition temperature of wood has been studied by many investigators (*vide* McNaughton, 1944). It is of interest not only for fire resistance studies but also in connection with spontaneous ignition in closed spaces (storage of fibre boards), etc. As with other combustible materials, the ignition temperature is not a constant but depends on the conditions of test. Wood begins to decompose at 275° C. with the evolution of combustible and non-combustible gases. Carbon monoxide, hydrogen and hydrocarbons have been identified in the former. Prinse (1915) showed that the "Ignition Point" is greatly influenced by the duration of exposure. In his experiments he noticed that at 180° C. ignition took place in 14.3 to 40 minutes. Recently, Jentsch and Jelitto (1953), using the Jentsch ignition tester with 14 wood samples varying in density from 0.15 to 1.0 g./cm.<sup>3</sup>, found this to vary from 240 to 310° C. Some years ago in connection with some work, we were interested in the ignition temperature and the combustible gases evolved on heating wood. The apparatus used is shown in Fig. 1. By showing a burning match stick to the issuing gas and noting the temperature of the electric furnace by means of a thermocouple the "Ignition Point" was found. The gases evolved were analysed in an Orsat apparatus. As further work is not contemplated at present, the results obtained are recorded in this note.

The ignition temperature for *Tetramesa nudiflora* was found to be 228° C. The composition of the gases evolved can be seen from the results given in Table I.



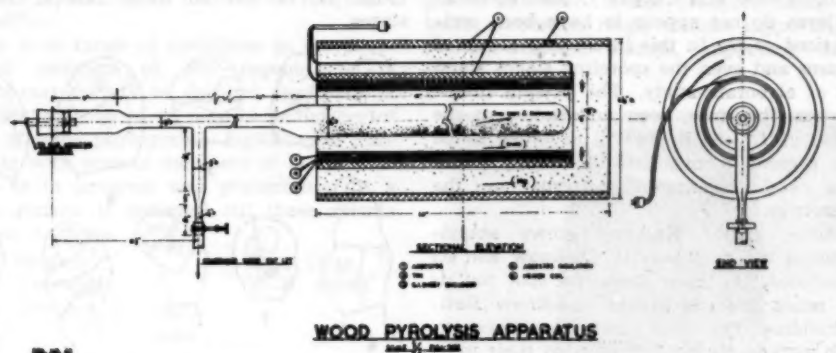


TABLE I  
Combustible gases from wood

Species	Moisture content %	Temp. at which combustible gases were observed to evolve	Temperature range during which gas was collected for analysis °C.	Analysis				Ratio Residual O <sub>2</sub>	Analysis after correcting for air		CO CO <sub>2</sub>
				CO <sub>2</sub> %	O <sub>2</sub> %	CO %	Residual gases % 100 - (CO <sub>2</sub> + O <sub>2</sub> + CO)		CO <sub>2</sub> %	CO %	
<i>Tetrameles nudiflora</i>	8.70	288° C.	231-287	36.4	3.8	45.6	14.2	3.74	44.39	55.61	1.25
<i>Alstonia scholaris</i>	10.92	..	235-295	40.1	5.2	35.0	19.7	3.79	53.40	46.60	0.87
<i>Dichopsis elliptica</i>	6.57	..	242-295	41.4	6.1	29.7	22.8	3.74	58.23	41.77	0.72

Klar (1910) found 30.5% of CO and about 68% of CO<sub>2</sub> when wood is heated between 150 and 200° C. According to Coppick (1947), about 35% of CO is evolved during the Pyrolysis of cotton. According to Sander (1957), the decomposition CO/CO<sub>2</sub> ratio is close to 1 for most untreated lignocellulosic materials and decreases rapidly with fire-retardant treatment to about 0.75.

In our experiments the ratio varied from 1.25 with the *Tetrameles nudiflora* specimen to 0.72 with *Dichopsis elliptica* specimen. Narayanamurti and Gopalachari (1943) found *Tetrameles nudiflora* one of the easily inflammable woods.

Composite Wood Branch, D. NARAYANAMURTI.  
Forest Research Institute, JOSEPH GEORGE.  
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### PATTERNS OF REGENERATION IN NOTOTHYLAS INDICA KASHYAP\*

WHILE extensive researches on sporeling germination and regeneration have been carried on in the Acrogynous Jungermanniales and the position has been ably discussed by Fulford,<sup>1</sup> the Marchantiales and the Anthocerotales, particularly the latter, have apparently received relatively little attention in this connection in the past. Thus, although the sporeling germination has been studied to some extent in the Anthocerotales (Hofmeister,<sup>2</sup> Grönland,<sup>3</sup> Leitgeb,<sup>4</sup>

Campbell,<sup>5</sup> Pandé and Chopra<sup>6</sup>), the regeneration patterns do not appear to have been seriously noticed so far in this interesting group of Cryptogams and even the sporeling stages stand in need of elaborate study. The present investigation has, therefore, been undertaken at the suggestion of Dr. S. K. Pandé, in order to be able to present a detailed discussion of the sporeling and regenerant patterns in the Anthocerotales.

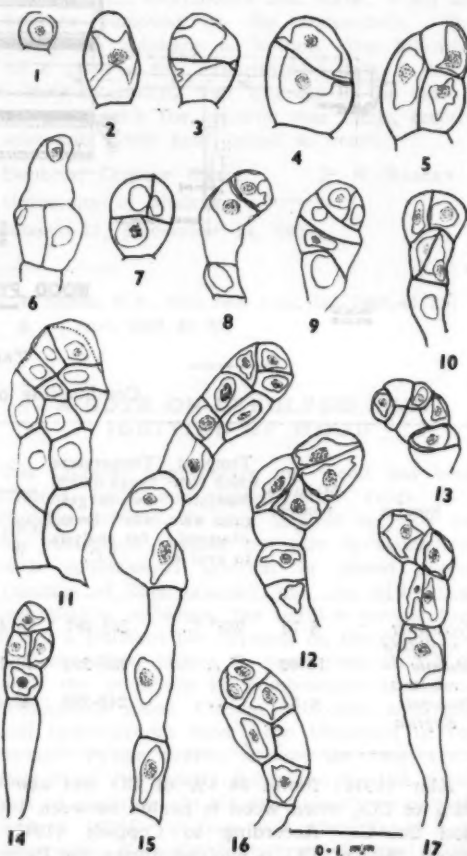
*Notothylas indica* Kashyap grows abundantly during the monsoons in Lucknow and its neighbourhood, the most favourite spot for its growth being the old historic Lucknow Residency Building. The local plants have been excellently worked out with respect to their morphological details by Pandé<sup>7</sup> and the sporeling patterns by Pandé and Chopra.<sup>8</sup> The present note gives an account of the regenerant patterns.

Full rosettes of plants along with soil, for this investigation, were collected from the Residency Building and brought to the laboratory. These were: (1) placed in covered Pyrex glass Petri dishes containing sterilized soil, from the home locality of the plant, with distilled-water, (2) treated with 0.02% NAA for 2 hours and placed as in (1), and (3) treated with 0.02% 2, 4-D for 2 hours and placed as in (1). Various stages of regeneration were obtained in about 2-4 weeks. Copious regeneration was observed in (2) whereas in (3) the plants were killed in about 3-4 days after culture, 2, 4-D possibly proving toxic in the concentration utilized for study. In (1), however, mostly ventral shoots developed.

The first indication of regeneration is that some of the thallus cells get dedifferentiated becoming papillate (Figs. 1, 2) and show relatively denser contents and prominent nuclei. Such dedifferentiated cells may occur on the dorsal and ventral surfaces of the thallus as well as along the margins. These divide transversely (Fig. 3), or obliquely (Fig. 4), to form two cells. Of the two cells thus formed, either the lower (Fig. 6), or the upper (Fig. 7), may divide first by a vertical wall. Subsequently, the other cell also divides in a similar manner (Fig. 12). In one case (Fig. 10), the lower of the two cells shows an oblique division.

Occasionally, there are some transverse divisions before any vertical walls are laid down (Figs. 8, 9, 12, 15, 17) forming a filamentous structure as described in the sporelings of *Anthoceros* by Leitgeb.<sup>4</sup> Ultimately an apical cell is responsible for the further growth

(Figs. 11, 13, 15) for some time in the early stages.



FIGS. 1-17. Fig. 1. A dedifferentiated cell. Fig. 2. An enlarged dedifferentiated cell. Figs. 3, 4. Two-celled regenerants. Fig. 5. Early establishment of an apical cell. Figs. 6, 7. Initiation of vertical division. Figs. 8, 9, 12, 15. Stages showing few transverse divisions before vertical septation starts. Fig. 10. A four-celled regenerant showing an irregular division in the lower half. Fig. 11. An advanced stage. Fig. 13. An early stage with an apical cell. Figs. 14, 16, 17. Elongation of the dedifferentiated cell before septation commences. In Fig. 16 the long tube not shown.

Quite often, oblique divisions are laid down in such a way as to cut off an apical cell rather early in the development (Fig. 5) much in the same way as in the formation of the sporelings in *Notothylas indica* (Pandé and Chopra<sup>8</sup>).

In some cases (Figs. 14, 16, 17) there is a certain degree of elongation of the dedifferentiated cell before septations commence as in the elongation of the germ tube in the forma-

tion of the sporeling of *Anthoceros fusiformis* (Campbell<sup>5</sup>).

Such a wide range of variations in the developmental patterns of the regenerants in *N. indica* may merely be cultural variations of an unimportant nature or may be indicative of features of some phylogenetic significance. Further study with several members of the Anthocerotales is in progress and presentation of a complete picture is deferred till these results have been finalized.

Dept. of Botany,  
Lucknow University,  
Lucknow, October 27, 1957.

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V. B. SINGH.

\* Contribution from the Department of Botany, Lucknow University, New Series, No. 26.

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\*\* Not seen in original.

# NOTE ON DIELECTRIC BREAKDOWN STRENGTH OF WOOD AND MODIFIED WOOD

As is well known, wood is preferred for many applications on account of its favourable physical properties. If we consider electrical properties it has a high electrical resistance (Narayanamurti, D., 1941), and low dielectric constant. As an insulator for many uses the dielectric breakdown strength has also to be taken into account. During the war, porcelain insulators used in the wireless masts of motor vehicles under certain conditions were found to break. These were replaced at the suggestion of the Forest Research Institute (Narayanamurti, D., unpublished work) by ones made of *Cupressus torulosa* (cypress) or *Tectona grandis* (teak) treated either with cashew shell oil, linseed oil or phenolic resin. These were found to be satisfactory by the user (Fig. 1). In addition, treated wooden pieces are often used as distance pieces of stator windings in generators and in the construction of transformers where the use of wood affects considerable saving in oil. The breakdown strength plays an important role wherever wood or modified wood is used in electrical equipment. For example, compreg finds application as lifting rods or

guides in 66 Kv. circuit breakers, links, switch bases, insulation rings, contact supporting bars, packing blocks, clamps, slipping barriers, etc.



FIG. 1

According to Kollmann (1955), the breakdown strength of dry wood is about 27-28 Kv./5 mm., that of marble 10-20 Kv./5 mm. and of transformer oil, 20-25 Kv./5 mm. In view of its importance a few measurements on Indian timbers across the grain were made in this laboratory. An apparatus similar to the one recommended by A.S.T.M. was adopted (Fig. 2).

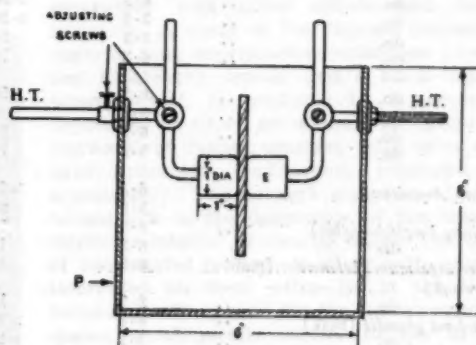


FIG. 2

With the transformer available voltages higher than 21 Kv. were not possible. All tests were done in air. The results of these preliminary

tests are given in Table I. The results are based on tests done on at least 2 samples. Results of other authors for other species are also included in the table for comparison.

Among the Indian timbers tested *Zanthoxylum rhetsa* haldu, and teak have a high value while mango, toon, chir, walnut, jaman have a low value. Treatment with creosote, paraffin,

TABLE I

Species	Thickness mm.	Breakdown voltage Kv.	Moisture content %	Remarks
<i>Acer</i> sp. (maple)	250.0	80.0	6.0	Vieweg & Pfestorf
<i>Adina cordifolia</i> (haldu)	6.3	> 20.5	7.0	
do.	3.2	19.5	7.0	
<i>Beech</i> plywood	6.0	12		
do.	6.0	42		Resin treated
do.	6.0	42		
	12.0	13		
<i>Carpinus betulus</i> (hornbeam)	250.0	80	5.0	Vieweg & Pfestorf
	6	6		
	12	8		Acc. to Burmeister dry control
	6	29		
	12	40		Resin treated
	6	34		
	12	50		Resin treated & lacquered
<i>Cedrela toona</i> (toon)	6.3	12.0	9.4	
<i>Cullenia excelsa</i> (Kaim) A.R.T.	6.3	15.5	0	
<i>Dalbergia latifolia</i> (rosewood)	6.3	12.0	..	
<i>Dichopis elliptica</i> (pali)	6.3	> 20.0	6.7	
<i>Dysoxylum malabaricum</i> (white cedar)	6.3	> 20.0	8.6	
do.	3.2	20.0	8	
<i>Dipterocarpus</i> sp. (gurjan)	3.3	15.5	Air dry	
do.	6.3	15.5	do.	
<i>Eugenia</i> sp. (jaman)	6.3	12.0	8.4	
<i>Fraxinus</i> sp. (ash)	250.0	80.0	4.0	Vieweg & Pfestorf
<i>Holoptela integrifolia</i> (kanju)	6.3	15.5	6.0	
<i>Mangifera indica</i> (mango)	6.3	12.0	7.5	
do.	6.3	> 20.5		Paraffin impregnated (1st 130° C. then 70° C. finally allowed to cool outside)
do.	3.2	20.0		C.N.S.L. impregnated (heated at 120° C.)
do.	6.3	> 20.0		Linseed oil impregnated (heated at 120° C.)
do.	3.2	> 20.5		P.F. resin treated. (50 p.s.i. & the ad)
do.	6.3	> 20.5		
do.	3.2	> 20.5		Alkathene treated (in melted alkathene)
do.	6.3	18.5		
do.	3.2	> 20.5		Creosoted (50 p.s.i.)
do.	6.3	16.5		
do.	3.2	21		
do.	6.3	15.5		Shellac treated (50 p.s.i.)
<i>Pine, American</i>	6.3	> 20.5	7.0	
	3.2	20.5	6.5	
<i>Pinus longifolia</i> (chir)	6.3	12.0	8.0	
do.	6.3	15.5	0.0	
<i>Stereospermum chelonoides</i> (padri wood)	6.3	19.0	8.0	
do.	3.2	15.5	6.0	
<i>Tectona grandis</i> (teak)	6.3	> 20.5	0	
do.	3.2	> 20.5	0	
do.	6.3	> 20.5	Air dry	
do.	3.2	18.5	do.	
<i>Terminalia myriocarpa</i> (hollock)	6.3	18	..	
<i>Zanthoxylum rhetsa</i> (kullilam)	6.3	> 20	8.4	
do.	3.2	> 20	3.7	



cashewnut shell oil and P.F. resin increases the breakdown strength.

Composite Wood Branch,  
Forest Research Institute,  
Dehra Dun, August 21, 1957.

B. N. PRASAD.

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### WHAT CONSTITUTES A 'NETWORK' IN MAMMALIAN NEURONES?

RECENTLY the author<sup>1,2</sup> reported the complete absence of the classical 'Golgi apparatus' in the ageing spinal ganglion cells of the frog. A similar view is held by the author on the neurones of mammals. Besides, a study of the spinal ganglion cells of the immature rabbits (1 to 1½ months old) and adult squirrels provide an evidence of the existence of what has probably been interpreted as the 'Golgi reticulum'.

Phase-contrast microscopy of the freshly teased neurones of the rabbit and squirrel reveals the existence of refringent, homogeneous spheroids of varying sizes dispersed throughout the cytoplasm. However, in the squirrel a few spheroids show a duplex structure, with a refringent cortex and a pale medulla. A careful and intensive study of these neurones, especially from the rabbit ganglia, shows that the ground cytoplasm is not always homogeneous all through. Occasionally there are lighter-appearing, irregularly rounded or elongate, areas which interrupt the cytoplasm of higher contrast. The number and size of these spaces of lower contrast varies considerably in different



FIG. 1. Living spinal ganglion cell of immature rabbit showing prominent clear spaces and small homogeneous spheroids in the cytoplasm,  $\times 1,200$ .

nerve cells of the same size; and in some cases their number may be so large that the cytoplasm of higher contrast, which consequently becomes confined to narrow strips in between the lighter spaces, gives the look of a continuous apparent grey 'network' (Fig. 1). This so-called cytoplasmic net probably represents the 'reticulum' of Adamstone and Taylor<sup>3</sup> in the living spinal ganglion cells of the rat; and the refringent spheroids which are entirely located in this so-called net of cytoplasm have been misinterpreted by them as the mitochondria. A similar appearance of the cytoplasm has also been observed in neutral red-stained living neurones of squirrel in which the cytoplasm of higher contrast has been lightly stained (Fig. 2).

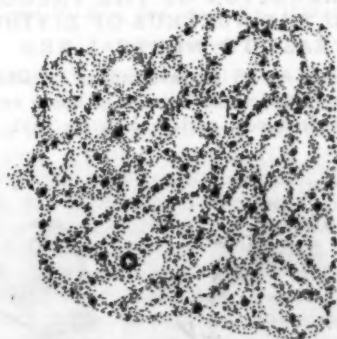


FIG. 2. Diagrammatic representation of the cytoplasm of the neurone of squirrel after staining in neutral red.

The network-like appearance of the cytoplasm is greatly accentuated by the action of fixatives, especially those which precede impregnation with silver nitrate and osmium tetroxide. A study of the finished preparations made by long impregnation techniques (Aoyama and Kolatchev) reveals that a black network, when formed, is produced by a non-specific deposition of silver or osmium on cytoplasmic 'network' of higher contrast, with intertwined lipid spheroids (sudanophil, osmiophil and argentophil). The network thus formed closely corresponds to the description of the 'apparato reticolare interno' of Camillo Golgi. The strings of precipitated osmium or silver with spheroids interposed on them often lie at the border, forming a sort of wall for the lighter-appearing spaces, which mostly become tubular in fixed preparations and appear as 'clear canaliculi'. The writer is not aware of the exact nature and significance of these spaces, but it seems definite that they do not conform to the definition of the classical 'Golgi apparatus'.

Moreover, there is no evidence of the existence of any argentophil material, distinct from the lipid spheroids, related to these 'canaliculi'. There is no doubt that indiscriminate use of silver nitrate and osmium tetroxide introduces serious artifacts, but if sparingly used, the essential form of the lipid spheroids is preserved just as in the living material.

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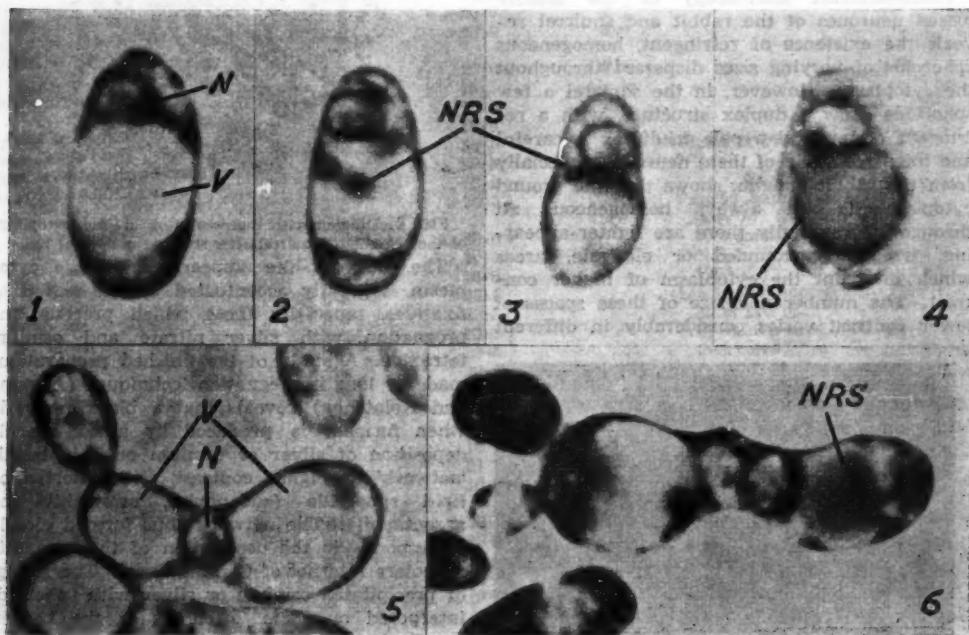
### THE REACTION OF THE VACUOLE AND THE NUCLEUS OF LIVING YEAST TO NEUTRAL RED

The nucleus is an extra-vacuolar structure in living vegetative cells<sup>1</sup> as well as spore zygotes<sup>2</sup> of *Saccharomyces carlsbergensis*. That these

two structures are unrelated to each other was shown in *S. cerevisiae* by stimulating the cells with visible nuclei by the addition of fresh medium.<sup>3</sup>

The least toxic among the vital stains is considered to be neutral red.<sup>4</sup> While the reaction of the vacuole to neutral red is rather specific,<sup>4</sup> the nuclei of higher organisms are rarely stained by it.<sup>5</sup> According to Guilliermond<sup>4</sup> (p. 136) when *S. ludwigii* is suspended in a dilute solution of neutral red, it precipitates and stains the vacuolar colloid which may then pass through the vacuolar boundary and get deposited in the peri-vacuolar cytoplasm. In later stages the stained granules dissolve and the vacuole is said to show an almost uniform staining.

Though Guilliermond repeatedly emphasized that the vacuole is not the nucleus of yeast,<sup>6</sup> the evidences adduced by him did not receive the attention they deserve because his experiments with neutral red were carried out on yeast cells in which the nucleus was invisible



PHOTOGRAPH 1. Unstained living vegetative cell showing the extra-vacuolar nucleus.  
PHOTOGRAPHS 2-4. The progressive staining of the vacuole after 15, 30 and 120 minutes of exposure to 0.01% neutral red.

PHOTOGRAPH 5. Unstained living zygote. The nucleus lies between the two vacuoles.

PHOTOGRAPH 6. A spore zygote after 120 minutes of exposure to 0.01% neutral red.

N, Nucleus; V, Vacuole; NRS, Structures stained by neutral red.  $\times$  ca 4,000.

in the living condition. The visibility of the nucleus in living vegetative cells and zygotes of *S. carlsbergensis* enabled a study of the reaction of the nucleus and the vacuole to neutral red.

The crop from cultures containing cells with visible nuclei<sup>1,2</sup> were collected, washed, and then suspended in a phosphate buffer of pH 7 for 15 min. They were then transferred to 0.01% solution of neutral red in distilled water and examined at intervals to follow the progress of staining. Photograph 1 is that of a living unstained cell showing the extra-vacuolar position of the nucleus. The nuclear membrane is clear and in this cell it has a crescent-shaped thickening in one region. When suspended in neutral red there is occasionally a non-specific tinting of the nucleus as well as the cytoplasm in cells which appear to be senescent.

In those with unstained cytoplasm and nuclei, granules coloured by neutral red appear inside the vacuole (Photograph 2) and exhibit brownian movement. They slowly increase in size, get attached to the vacuolar periphery and assume a semi-lunar shape (Photograph 3, NRS). Often they may be seen migrating into the cytoplasm. In later stages, the interior of the vacuole appears uniformly stained, the colour being deeper at the periphery of the vacuole (Photograph 4). Attention is invited to the fact that the accumulation of the dye at the periphery is not uniform.

Photograph 5 is that of a living unstained spore zygote. When the zygotes are suspended in neutral red, the two vacuoles exhibit differences in behaviour. In Photograph 6, one of the vacuoles appears uniformly stained, while the dye has collected at the periphery of the other vacuole in an irregular fashion.

The appearance of grains and crescents inside the vacuole (Photographs 2, 3, 4 and 6, NRS) on staining with neutral red necessitate their being considered as neo-formations, since these structures have no existence in the living unstained yeast (Photographs 1 and 5). During these changes in the vacuole, the nucleus exhibits no visible alteration and neither could any granules coloured by neutral red be seen inside the nucleus. Mounting the cells in neutral red, however, improves the contrast of the nucleus in micrographs.

The reaction of living yeast cells to neutral red reinforce the earlier work<sup>7,8</sup> that the vacuole and the nucleus are unrelated structures.

I am very grateful to Dr. M. K. Subramaniam for his guidance and encouragement.

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Bangalore-3, November 11, 1957.

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#### ROOT INDUCING SUBSTANCE IN GROUNDNUT SEEDS

THE oil of the groundnut seed has been shown to possess growth-promoting (De Souza and Sreenivasaya, 1942) and mutagenic (Swaminathan and Natarajan, 1956) properties. The aqueous extract of seeds of a bunch variety of groundnut (TMV. 2) has been noted to break seed dormancy of spreading type of groundnut (Bhavanishanker Rao, 1956). Besides all these important properties another interesting observation is reported here.

Seeds of a spreading dormant variety (TMV. 3) of groundnut were soaked in aqueous extract prepared from seeds of a bunch variety (TMV. 2) and germinated in sand with a view



FIG. 1. Seedlings showing adventitious root formation.

to study the effect of the aqueous extract on breaking of dormancy. The seedlings that germinated showed an interesting phenomenon of adventitious root formation from the cotyledonary bases and stalks (Figs. 1 & 2). These roots were di- or triarch in trans-section. It is of interest to note that similar cases of root development from cotyledonary bases and stalks have been reported in seedlings of *Phaseolus vulgaris* L. (Malabotti, 1946) and Apricot (Bradley, 1957) due to treatments with heteroauxin ( $C_{20}H_{13}O_{11}N_2$ ) and 2, 4, 5-T and 2, 4, 5-TP respectively.

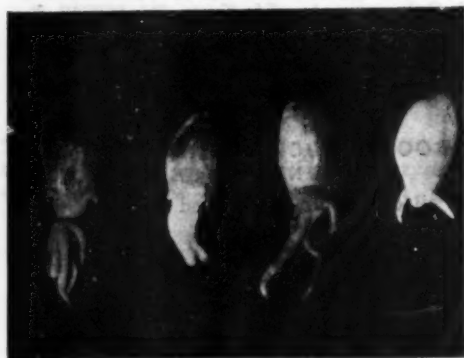


FIG. 2. Cotyledons showing root development from bases. (Cotyledons removed from the seedlings are shown separately.)

Adventitious root formation was noted only in treatments where the seeds were soaked in TMV. 2 groundnut seed extract and not in those where the seeds were soaked in water. Hence it is clear that the seed extract contains a root-inducing substance which shows properties like synthetic auxins.

The seeds of the bunch variety groundnut, TMV. 2, are highly non-dormant and they germinate in the field itself when rains are received at the time of harvest. Of the various varieties studied, only the bunch non-dormant variety exhibited the property of inducing adventitious root formation and hence its non-dormant nature may be due to the possible presence of a root-inducing substance in the seeds. Further studies are in progress with other bunch varieties and the results are being reported elsewhere.

The authors wish to record the help and guidance given by Professor T. R. Narayanan,

Systematic Botanist and Plant Physiologist, in preparing this note.

Oilseeds Section, S. S. NAGARAJAN,  
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### BACTERIAL LEAF-SPOT OF *Pennisetum typhoides*

DURING 1956-57, a leaf-spot disease of *Pennisetum typhoides* Stapf. and Hubbard (The Pearl Millet, Bajra or Cumbu) was widely prevalent in the fields of the Agricultural Research Institute, Coimbatore. The disease was found both in the main and off-season crops. Symptoms first appear as water-soaked spots on the upper surface of the leaf, which turn reddish-brown in 2-3 days. With age, the spots enlarge, becoming rectangular in shape, 2-5 mm.  $\times$  1-3 mm. in size, bound by the vascular margin on the sides, and chocolate-brown in colour. No halo is found around the spots, but on maturity the spots are found to be markedly depressed from the surface of the leaf. Plants of all ages and all the leaves in the plant are commonly affected, but no other parts of the plant except the leaves seem to be infected. Transverse sections of the leaves through the spots clearly indicated the vascular nature of the disease, the causal bacterium being confined mainly to the bundles. The bacterium was readily isolated by the tissue culture and the dilution plate methods.

There seems to be no previous record of any bacterial disease on the host. One of the related species, *P. purpureum* Schum, however, has been reported to be, on artificial inoculation, infected by *Xanthomonas vasculorum* (Cobb) Dows., the causal organism of gumming disease of sugarcane<sup>1</sup> and *Bacterium albilineans* Ashby, the organism responsible for the leaf-scald of sugarcane.<sup>2</sup> The bacterium isolated from *P. typhoides* widely differs from the above two species in its morphological and physiological properties and in its pathogenicity and is, therefore, proposed to be assigned a new name, *Xanthomonas penniseti* Sp. nov.

*Xanthomonas penniseti* Sp. nov., Sowmini



Rajagopalan and Rangaswami: Short rods,  $0.7-1.1 \mu \times 1.4-2.1 \mu$  single or sometimes in chains of two or three, monotrichous with single flagellum, aerobic, gram-negative, capsulated, non-spore-forming, and non-acid fast. Forms yellowish brown colonies on nutrient agar, the colonies are circular, smooth and shining, with entire margin. Growth in nitrate broth dull-yellow with sedimentation in 2 days. No soluble pigment produced in the liquid or solid media. Gelatin liquefied in 2 weeks, starch hydrolysed, quick growth in litmus milk, casein hydrolysed, litmus not reduced, hydrogen sulphide not produced from peptone, ammonia and nitrite produced in 5 days, negative Indol and positive M.R. and V.P. tests. Acid and gas produced from glucose, maltose, sucrose, arabinose, levulose, starch, galactose, mannitol and salicin and no growth in xylose.

Causes leaf-spot on *Pennisetum typhoides* Schum, but on artificial inoculation failed to infect *P. purpureum*, *Sorghum vulgare* Pers., *Saccharum officinarum* L., *Setaria italica* Beauv., *Triticum vulgare* Vill., *Zea mays* L., *Oryza sativa* L., *Eleusine coracana* Gaertn., *Solanum melongena* L., *Datura metel* L., and *Lycopersicon esculentum* Mill.

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October 15, 1957.

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# THE COFFEE LEAF-MINER, *AGROMYZA (MELANAGROMYZA)* *COFFEAEE* HERING (DIPTERA: AGROMYZIDAE)

Of the leaf-miners of coffee, those belonging to the order Lepidoptera are known to cause severe damage to coffee plants in Brazil, Kenya, East Dutch Indies<sup>1,2</sup> and some other countries. Among Diptera, *Oscinis coffeaee* Kon., and *Anthomyza coffeaee* N. are recorded as minor pests of coffee.<sup>1,3,4</sup> The Agromyzid, *Agromyza (Melanagromyza) coffeaee* has been reported to mine coffee leaves in Tanganyika (Hering<sup>5</sup>) and recently in Kenya (in a private communication from the Director, Commonwealth Institute of Entomology, London). A brief account of this leaf-miner, which

is now reported here for the first time in India on coffee, is given below.

The adult is a small black fly measuring about 2 mm. in length with its body covered with faint grey dust which produces a silky gloss. Head is slightly compressed antero-posteriorly, with prominent and slightly reddish eyes. The larva is cylindrical and pale yellow in colour measuring nearly 2 mm. when fully grown. It is highly specialised, the normal mouth parts being replaced by the pharyngeal skeleton serrated at the tip, well suited for mining in the leaf. The pupa is dark brown measuring about 2 mm. in length.

The eggs are deposited below the upper epidermis of tender and fresh coffee leaves, usually one in each leaf. The larva on hatching starts mining in the mesophyll layer under the upper epidermis. By feeding on the mesophyll they progressively make irregular, sinuous mines, shining in appearance (Plate I). Normally the

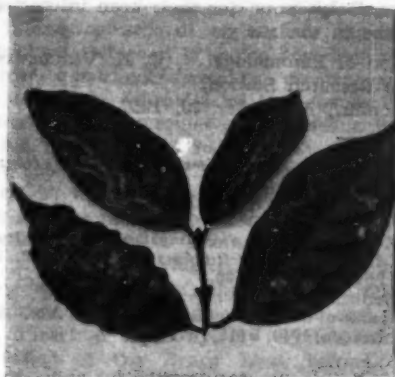


PLATE I

larvae seem to feed for 7 or 8 days before pupation. Pupation takes place at the terminal end of the gallery, within the hardened larval skin, which forms a protective shroud. Adults emerge in 11 to 13 days under favourable conditions by breaking open the pupal chamber and the epidermal layer of the leaf.

At the Coffee Research Station, Balehonnur, this leaf-miner has been noticed to be very active during the months following the summer showers reaching maximum incidence by June-July. Thereafter, there appears to be a recession in the pest incidence as dry weather sets in, the pest practically disappearing by January-February. The pest appeared in a severe form in 1956 at the Research Station nursery on young *arabica* coffee plants. Otherwise, it is generally observed as a minor pest attacking

new flush on young and old plants. Attacked leaves are distorted and sometimes present wrinkled and fluted appearance.

Two Eulophid parasites, [Hymenoptera] (a) *Closterocerus* Sp., and (b) not determined, have been observed to parasitise this leaf-miner at the Station during the months of March and April and again in September and October. These parasites have been observed during the same period, the former occurring comparatively in larger numbers. Parasitization seems to be fairly high (about 80%) during the pre-monsoon period. It may be possible that these parasites have checked the multiplication of the insect to a large extent.

My grateful thanks are due to the Director, Commonwealth Institute of Entomology, London, for taking the trouble in identifying the insect and supplying the information on its previous records. I am also indebted to the Director and Entomologist, Coffee Research Station, Balehonnur, for their keen interest and guidance in the study.

Division of Entomology, C. K. VASUDEVAN.  
Coffee Research Station,  
Balehonnur, November 29, 1957.

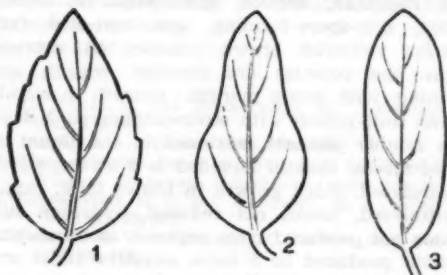
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#### EXPERIMENTAL INDUCTION OF LEAF HETEROMORPHISM IN *SESAMUM INDICUM* L.

CONSIDERABLE degree of leaf heteromorphism is known to occur in *Sesamum indicum* L. Sen and Pain<sup>1</sup> recorded that in normal plants of varieties I.P. 7 and I.P. 29, the lower leaves are ovate-lanceolate in shape while those in the apical region are linear-lanceolate with a large number of intermediate forms in between.

While investigating the effects of reduced carbohydrate supply, brought about by the removal of cotyledonary leaves and of shoot apices soon after germination, on the flowering of T. 10, certain interesting changes in the outline of the lamina and its margin are recorded. In the former case, the pair of leaves de-

veloped at the node just above the cotyledonary one, instead of being of the normal ovate type (Fig. 1), exhibit prominent concavities on both



FIGS. 1-3

the sides which are nearer the apex than the base (Fig. 2). Subsequent leaves borne by the plant, however, do not show any abnormality. Changes in the shape of leaves referred to above cannot be induced by removing one of the cotyledons only.

Lowest leaves on branches developed at the axil of the cotyledons after decapitation are oblong (Fig. 3). Subsequent ones, however, gradually change to the normal type through a number of intermediate forms. Margin in both the new types of leaves are entire in contrast to serrate in the normal.

An uniformly similar response has been recorded in as many as 30 plants subjected to the removal of cotyledonary leaves and 15 to that of decapitation in the month of July 1957.

No change in the form of leaf in the following plants could be brought about by subjecting their seedlings (15-20 observations) to similar treatments:

- Phaseolus radiatus* L.
  - Vigna catjung* Endl.
  - Lens esculanta* Moench.
  - Cicer arietinum* Linn.
  - Lagenaria vulgaris* Ser.
  - Luffa aegyptiaca* Mill.
  - Cucumis sativus* L.
  - Cucumis melo* L. var. *Momordica*.
  - Ricinus communis* L.
  - Brassica campestris* L. and
  - Linum usitatissimum* Linn.
- Further studies are in progress.

Dept. of Botany, S. C. CHAKRAVARTI.  
Govt. Hamidia College, B. K. ARORA.  
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## REVIEWS

**Quantum Chemistry—An Introduction.** By Walter Kuzmann. (Academic Press, Inc., New York), 1957. Pp. xii + 744. Price \$12.00.

The topics dealt with in this book are of interest to the physicist and chemist alike. Several books on quantum chemistry have appeared in recent years of which the best known perhaps is that by Eyring, Walter and Kimball, but even this can be expected to appeal only to the theoretical chemist with a strong mathematical bias in view of its terse style. The volume under review in which "the necessary mathematics is presented in a more extended and more understandable form" will prove to be useful to a wider circle of chemists interested in understanding the important concepts that quantum mechanics has introduced into chemistry.

In the voluminous text of over seven hundred pages, the author has tried to carry out the ambitious plan of not merely expounding the application of quantum mechanics to molecular systems and the solid state, but also to provide the student with the necessary background of mathematics and the principles of quantum mechanics alongside with its applications in atomic physics. The author supplies the mathematical tools necessary to understand the subsequent chapters in Part I, while in Parts II and III, the principles of quantum mechanics and their application to atomic problems are developed. The contents of these two parts are the same as that to be found in the innumerable text-books available at present on quantum mechanics. Chapter 5, dealing with the principles of quantum mechanics reads more like a summary than an exposition of the subject, and it is doubtful whether the beginner, for whom the book is intended for, will be able to grasp the subject with this sketchy presentation without obscurity clouding his ideas. But, in a book of this sort wherein the author aims at covering a wide range of topics, such a condensation of some part or other becomes inevitable.

Part IV deals with the chemical binding of atoms into molecules which is a problem of fundamental importance to the physical chemist. Chapter 11 contains a sketch of the Heitler-London theory for the hydrogen molecule, the concept of hybridisation advanced by Pauling to explain the tetra-valency of carbon

and the molecular orbital treatment of the benzene molecule. The author begins the next chapter with the famous quotation of Dirac, viz., "The underlying physical laws necessary for the mathematical theory of a large part of physics and the whole of chemistry are thus known" which is pleasing to every physicist, but he retorts soon with the challenge that the claim here is made "in principle" and not "in fact". Indeed, the application of wave mechanics to complex molecules is beset with insurmountable mathematical difficulties and the author rightly points out the necessity for renouncing even at the outset the attempts to obtain precise solutions of the Schrodinger equation. He emphasises the fact that ingenious chemical ideas can lead one to wave functions closer to the correct one. The chapter contains an interesting account of nuclear quadrupole moments in which it is shown how data on the nuclear quadrupole coupling constant enable one to obtain estimates of the charge distribution of the molecules and consequently get a clue regarding the nature of the electronic wave functions.

Part V, which is the last of the book, deals with systems in non-stationary states, i.e., time-dependent processes. The topics dealt with in this part are very wide indeed, and to mention a few, include Lorentz's theory of electrons, the scattering of light by gases, liquids and solids, the diffraction of X-rays by crystals and the derivation of the Bragg Law, refraction of light, optical rotatory power and the colour of substances. In each case the author has tried to bring out the essential physical principles that he seeks to explain.

The printing and get-up of the book are of a high order. The book can warmly be recommended to all students of physics and chemistry interested in the application of quantum mechanics to atomic and molecular systems.

K. S. V.

**Solvents.** Seventh Edition. By Thomas H. Durrans. (Chapman & Hall), 1957. Pp. 244. Price 30 sh.

A solvent may be defined as a liquid substance capable of bringing a solid to a fluid state. This definition, although defective and inadequate, expresses the general idea underlying the use of solvents. In industrial chemical processes solvents play a very vital role

and these are almost wholly organic compounds having a wide range of physical properties and specificity of solvent power.

Though the use of solvents is by no means restricted to any single particular group of compounds, they have been closely interwoven with the development of plastics and with the addition of newer and newer kinds of plastics, a long list of them have been brought to use. Anyone dealing with solvents should be thoroughly acquainted with their characteristics and it is with this object in view, the book under review has been written.

The first part deals with some important properties of solvents and these appear under eight small chapters bearing the titles (I) Solvent action, (II) Solvent power, (III) Plasticising solvents, (IV) Solvent balance, (V) Viscosity, (VI) Vapour pressure, (VII) Inflammability, and (VIII) Toxicity. In Part Two of the book, no less than 200 compounds are dealt with under nine chapters. The compounds are classified under: (I) Hydrocarbons and sundry solvents, Nitro paraffins, (II) Alcohols and their ethers, (III) Ketones, (IV) Esters, (V) Glycols and their ethers, (VI) Cyclohexane derivatives, (VII) Chloro compounds, (VIII) Furanes, and (IX) Plasticising solvents. Under each compound its characteristics, specificity of solvent action toxicity, their uses and in many cases their method of preparation are given. Two appendices appearing at the end give the commercial names and probable composition, and a solubility table respectively. Many of the solvents listed in the book are employed in physical, chemical and medical laboratories for various purposes and a knowledge of their characteristics is therefore very desirable, especially their toxic properties, the harmful effects of which are underestimated and even overlooked. It is unnecessary to stress the usefulness of the book as its popularity is reflected in the number of editions that have appeared so far, since its first appearance in 1930; the present one being seventh revised edition. This monograph in applied chemistry is in the opinion of the reviewer a very useful reference book which ought to find a place in the shelves of chemists and even physicists.

**A Second Course of Electricity.** By A. E. E. McKenzie. (Cambridge University Press), 1956. Pp. viii + 357. Price 18 sh. net.

The appearance of the reprinted edition of this well-known text-book shows that the book is meeting a genuine need among students of electricity.

As the author has stated in the preface, the traditional treatment is adopted. The fundamentals are presented in a clear and elegant manner. The first three chapters deal with electrostatics. The next three chapters are devoted to the study of magnetism and electromagnetism. Most of the remaining chapters treat conventional topics in current electricity.

The title of the book should not be taken literally. The book contains two valuable chapters on modern physics. In the chapter on atomic physics, a large amount of useful information is given about radioactivity, the subject being brought up-to-date by the inclusion of some details connected with atomic fission. The chapter on electromagnetic waves gives some interesting facts which include a remarkably lucid account of radar and its applications.

The C.G.S. system of units is used but a reference is made to the advantages of the M.K.S. system. Though this system was officially accepted in 1935 by the International Electrotechnical Commission, physicists have not taken kindly to the alteration.

Attention has been drawn to the view (which follows from some assumptions in the M.K.S. system) that B and H in magnetic materials are physically identical. This, no doubt, simplifies dimensions and eliminates  $\mu_0$  (and similarly  $k_0$  in electrostatics) from many formulae. There is also the other suggestion that  $\mu_0$  should be taken as  $4\pi \times 10^{-7}$  followed by some authors like Harnwell. It is however doubtful whether these treatments will be suitable for the level for which the book is intended.

The book contains a large number of worked examples. At the end of most of the chapters, a collection of useful problems is given, these having been selected with great care and properly graded. The diagrams are neat, clear and effective.

The format and binding greatly add to the attractiveness of the book. The volume is recommended as an excellent text-book for the B.Sc. standard. S. R. R.

**Vitamin A.** By Thomas Moore. (Elsevier Publishing Company, London W 8), 1957. Pp. xx + 645. Price 76 sh.

This book written by one who has been engaged in research on vitamin A and other aspects of nutrition for the past 30 years is the most comprehensive and compact source of information on vitamin A yet available. Though the vitamin proved to be a challenge to the organic chemist for more than a decade and a half, the conquest was over by 1947. Large



quantities of the synthetic vitamin are produced nowadays at competitive prices and the vitamin has now lost its thrill and excitement for the chemical investigator. But the interest in the vitamin on account of its biological properties continues. Thousands of papers have already been published on this topic but the tempo of research continues unabated, and not all workers are conversant with all the work. We find compiled in this book all the information available on vitamin A, its provitamins, particularly carotene, its derivatives and congeners. The fields covered include spectroscopy, chemistry, physiology, biochemistry, endocrinology, pathology, nutrition, medicine and animal husbandry.

The book is divided into eight parts, each part dealing with one particular aspect of the vitamin, such as chemistry, pathology, etc., and there are a total of 39 chapters. At the end of most of the chapters there is a summary which is usually in the form of running matter but occasionally in the form of tabular statement. Each chapter has its own bibliography given at its end. The final chapter entitled, "Assessment of our present knowledge of vitamin A" serves to remind us of the track still to be traversed on the biological side. Our knowledge of the biochemistry of the vitamin A is adequate only with regard to the very small amount of it present in the retina of the eye. This constitutes only about 0.1% of the total amount of the vitamin present in the human body and we have no idea yet of the biochemistry of the remaining 99.9%. Again, though it has been known for nearly 30 years that the animal system is capable of converting carotene into the vitamin, there is still no unanimity of opinion as to the mechanism of the change. These two examples are sufficient to show how difficult biochemical investigations can prove.

The book is written in an easy style. It has an Appendix containing much useful information and a comprehensive author index and subject index. The printing and get-up conform to the high standard which the Elsevier Publishing Company have established for themselves.

The only criticism which the reviewer can make is that the matter designated "Demonstration of the method by which the systematic name of vitamin A was derived" occupying the whole of page 99 is too elementary and out of tune with the general standard of the rest of the book.

The book will be an indispensable companion to all research workers in the field of vitamin A, and, besides, will be a valuable work of refer-

ence in all institutions offering courses in nutrition, dietetics, physiology, biochemistry, medicine and animal husbandry.

S. R.

**Methods of Enzymology, Vol. III.** Editors: S. P. Colwick and N. O. Kaplan. (Academic Press, Inc.) Pp. xxiv + 1054. Price \$26.

This volume, the third in the series, has maintained the same high standards for which its two predecessors were commended by the present reviewer. This treatise is devoted to the synthesis, isolation, qualitative detection, quantitative determination and properties of the numerous substrates and coenzymes corresponding to the enzyme systems described in the previous volumes. The book is divided into seven sections dealing with carbohydrates, lipids and steroids, citric acid cycle compounds, proteins and their derivatives, nucleic acids and their derivatives, coenzymes and related phosphate compounds, in all comprising of nearly 150 articles all of which are thorough and exhaustive in details. The articles under each section range from general procedures of isolation, etc., to highly specialised and recently developed techniques of preparation and assay of substrates. The last section on the determination of inorganic compounds should prove a useful addition. Even a cursory glance at the table of contents indicates the successful application of chromatographic procedures, column as well as paper for the isolation and assay of a wide array of metabolites. Some of the recently discovered metabolites such as carbamylphosphate and the various nucleoside di- and triphosphates involved in nucleic acid synthesis have promptly lined up with their elders in the volume. The treatment given to the specialised topics is both selective and comprehensive. The editors and the advisory board have indeed done a magnificent job in not only enlisting well over a 150 contributors with varied and specialised interests but also in giving this volume the smart and flawless form it has. The book is complete with two indices and an index to abbreviations of metabolites is a praiseworthy feature, since the modern biochemical terminology looks almost a jigsaw puzzle of all conceivable abbreviations. This volume will be of immense help on the bench to all biochemists, students and advanced workers alike, and the fourth volume in this major compendium will be eagerly awaited. In short, like its predecessors, Volume III is a must in any biochemical laboratory. It

should be added that it has all the accomplishments of an Academic Press volume, nice printing and get-up, absence of misprints, etc., and its high price is no exception to tradition.

K. V. GIRI.

**The Effects of the Sulfonyl Ureas and Related Compounds in Experimental and Clinical Diabetes.** Edited by R. Leyne. (*Annals of the N.Y.A. Sciences*, Vol. 71, Art. 1, 2 East 63rd Street, New York-21), 1957. Pp. 1-292. Price \$4.00.

In the history of science it is not uncommon to find that fortuitous observations in a field have paved the way for outstanding discoveries in another field far removed from the original one. The discovery of sulfonylureas as anti-diabetic agents is a glaring instance of such chance observation and shows that the medical scientist of today has to be constantly alert about happenings in fields apparently unrelated to his own. The breath-taking pace at which medical science is progressing makes it a formidable task indeed, for the medical scientist to keep up such attitude of alertness. Nevertheless, the lesson of sulfonylureas shows that if maintained with assiduity such alertness can bring rich returns.

The sulfonylureas were originally brought to use as more soluble sulfa drugs with prolonged action but their effects in diabetes were consequences of Janbon's unexpected finding that one of them produced a disorder very similar to hypoglycaemia. Loubatierès immediately recognised their potentiality as anti-diabetic agents and his researches evoked considerable interest among workers in diabetes. As a result, considerable amount of information on these compounds accumulated within a relatively brief span of time.

Diabetes as a worldwide problem hardly needs any introduction. It is therefore in the fitness of things that the N.Y. Academy of Sciences convened the present Conference on Sulfonylureas. The number of the *Annals* containing the papers lists altogether 33 titles covering virtually every aspect of the action of these compounds. The list fittingly opens with a paper by Loubatierès which chronicles the history and development of research on sulfonylureas in relation to diabetes from 1942 to 1955. This is followed by papers describing the influence of endocrines on the action of these compounds; their metabolic effects on glucose, pyruvic acid, lactic acid and insulin; the role of insulinase in hypoglycaemic response induced by them; and their mechanism and

site of action in experimental animals and man. Last but not the least are the papers of a pure clinical nature, and those embodying observations on side effects and toxicities. The coverage of problems has been wide and all-embracing, but the reviewer feels that a grouping of the material under broad heads like metabolic, biological and clinical studies would have been more convenient for ready reference.

The major impressions gained after a perusal of the papers are that some of the sulfonylureas can and do control glycosauria and hyperglycaemia in the adult onset diabetic with a frequency of success varying from 60 to 80%. Unfortunately, the treated patient has to be subject to the same dietary control as is employed for insulin therapy. It has also been shown that any complication, such as an infection, may require the temporary use of insulin, and as such instruction in the administration of this hormone must never be neglected. It would, therefore, appear that to the practising physician and the patient, the sulfonylureas have no advantage over insulin. Nevertheless, these compounds have served the most important purpose of giving a fillip to research on many unsolved aspects of the diabetes problem. Indeed, their discovery might prove to be a landmark in diabetic research.

The N.Y. Academy of Sciences is to be congratulated for publishing this excellent number of the *Annals* on sulfonylureas.

N. N. DE.

**The Storage of Seeds for Maintenance of Viability.** By E. Biasutti Owen. (Commonwealth Agricultural Bureaux, Farnham Royal, England), 1956. Pp. v+81. Price not given.

Genetic stocks, consisting of seeds of crop varieties and of related wild species and genera, are being built up at the agricultural experiment stations in India and abroad. There is, therefore, an urgent need of keeping these stocks of valuable seeds in a viable condition for a number of years. It is very encouraging to learn that this publication for the first time brings together in a systematic manner the relevant literature dealing with the storage of small quantities of seeds against loss of viability. Pertinent literature has also been compiled relating to the storage of large bulks of seeds.

Information is given on the longevity of seeds of field-, pasture- and horticultural-crops, and some wild plants, and the factors affecting

their viability. Certain subjects which have a bearing on seed storage have also been examined, such as: changes in respiration and chemical composition of seeds; conditions inducing growth of fungi; dormancy; hard-seed-ness; seed treatment and genetical factors. The chapter on genetical aspects of seed storage has been contributed by T. Ashton. The publication contains a useful appendix summarising information on viability of seeds after storage for different periods, under different conditions and gives the relevant reference.

N. L. DHAWAN.

'Venoms'. Edited by Elenor E. Buckley and Nandor Porges. (American Association for the Advancement of Science, Washington, D.C.), 1956. Pp. xii + 467. Price \$9.50.

This book is a collection of papers presented at the First International Conference on Venoms held at the Annual Meeting of the American Association for the Advancement of Science, from December 27 to 30, 1954, at Berkeley, California. The book has 61 papers, contains 113 illustrations and has a good index. Workers from all countries except the Communist countries excluding Yugoslavia have contributed papers. There are six papers from workers in India. The papers cover a wide range of subjects including pharmacology, biochemistry, use of venoms as a source of specific enzymes, production and standardization of antivenenes, treatment of bites of poisonous animals, etc. This is not surprising since an article by C. B. Pollard has for its title: "Venom Research: A Challenge to the Various Sciences". Altar Meister of the National Cancer Institute, Bethesda, has reported some very interesting work on the use of snake venom L-amino acid oxidase in the preparation in high yields of -keto-acids from the appropriate L or DL-amino acids, and also in the preparation of D-amino acid in high purity from a racemic mixture. Venoms are a rich source of many enzymes and it is possible that further work might reveal more uses of these enzymes as biochemical agents. There is also the possibility of their application in medical therapy.

In a paper by Swaroop and Grab, the annual mortality due to snake bites in the whole world excluding USSR, Central Europe and China, is estimated as 30 to 40 thousand. For India the annual death rate estimated from recorded snake bites is 5.4 per 100,000 population, which works out to about 20,000 per year. This high death rate should induce more workers in India to work on snakes, venoms and on protection against bites of venomous snakes.

The book covers a great deal of information which would otherwise require very laborious search in the literature of the different sciences. The book will be read with great interest by scientists in all fields and it is sure to stimulate in them further interest in this fascinating subject of poisonous animals and their poisons.

#### Pharmacognosy of Ayurvedic (Kerala) Drugs.

Series 1, No. 3. (Published by the Central Research Institute, University of Travancore, Trivandrum), 1957. Pp. ii + 109. Price not given.

The previous number was reviewed by the undersigned in Vol. 23, No. 3 (March 1954) of this *Journal*. The present number deals with 20 medicinal plants from which 11 drugs are obtained. *Desmodium pulchellum* is given as one of the source plants for *Lodhra*. In most parts of the country species of *Symplocos* only (which are also given as source plants of *Lodhra*) are taken as the source of *Lodhra*. Probably in Kerala even *Desmodium pulchellum* Benth. is a source plant of *Lodhra*.

It is interesting to note that in the coastal Andhra Districts, the source plant of *Laksmana* is a species of *Solanum*, while in Kerala it is got from *Ipomoea sepiaria*, *Konig* and *Ipomoea obscura* Ker-gaul. It is said that "all authors are unanimous that *Laksmana* cures sterility in women. This claim is supported by the experience of many physicians though controlled clinical statistics are not available".

A more careful proof-reading would have avoided a printer's error like *Meria* for *Melia* in the contents.

The book is well got-up. The description and figures are well done. The chemical notes, promised in an earlier volume, are eagerly awaited.

The University of Travancore is to be congratulated on this pioneering venture, which will make *Ayurveda* better understood by the modern men of science.

K. S. RANGANATHAM.

#### Books Received

*Elementary Organic Chemistry*. By A. Saraswati. (S. Viswanathan, Acton Lodge, 11, McNichol Road, Madras-31.) Pp. ii + 336. Price Rs. 3.

*Cosmetics Science and Technology*. Edited by H. D. Goulden, Emil G. Klarmann, Donald H. Powers and Edward Sagarin. (Interscience Pub., New York.) Pp. xix + 1433. Price \$25.00.

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## SCIENCE NOTES AND NEWS

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### Temperature of 5 Million Deg.

Experiments at Harwell are widely believed to have provided the first evidence of the bringing about of fusion reaction under conditions of high temperature in a laboratory. Although this is no more than a first step towards the much more difficult achievement of bringing about the release of energy in this way on a useful scale, it is an important result scientifically. In the Harwell experiments the same reaction would have been brought about by pulsed heavy current electrical discharges, in a ring-shaped gas discharge tube filled with a mixture of heavy hydrogen and tritium at low pressure.

The temperature reached was believed to have been of the order of five million degrees Centigrade. In the conditions of the experiment, this should have been enough to bring about the fusion reaction on a sufficient scale to be detectable. The most sensitive means of detection is through the emission of neutrons as a product of the reaction.

During the passage of heavy current through the gas the discharge column is constricted into a narrow pencil which is unstable laterally. In order that high temperatures should be produced and contained, it is essential that the pencil, which contains the region of high temperature, should be prevented from contact with the tube walls.

This means that instability of the gas column must be controlled, it has been shown at Harwell that effective control can be secured—at least under moderate conditions of discharge—by an arrangement of magnets outside the tube.

This was an important advance, but it is recognised that the problem will in all probability become much more severe as the currents used are made bigger.

### South Pole Snow Pit

The International Geophysical Year Committee of the National Academy of Sciences has announced that a snow pit dug at the Amundsen-Scott IGY South Pole Station had reached a depth of 50 ft. on October 1. The pit, which has been dug by hand during the Antarctic winter, serves a dual purpose: the successive levels of snow laid bare provide an unspoiled record of climatic and other history, and the

snow itself is melted for the station's water-supply.

The temperature in the pit is nearly constant at  $-60^{\circ}\text{F.}$ , while at the surface a record temperature reading of  $-102.1^{\circ}\text{F.}$  was recorded on September 17. During the period May 11 to September 17, South Pole temperatures were lower than  $-95^{\circ}\text{F.}$  17 times.

A study of snow stratification, combined with examination of snow crystals and density, yields a history of the Antarctic. For example, traces of ash may indicate that a volcanic eruption took place hundreds of years ago, and pollen deposits provide a clue to past wind systems. Paul Siple is scientific leader at the Pole station, where there are eight other scientists and a similar number of Naval personnel.

### Cold Vaccine

On September 19, 1957, Winston H. Price, Associate Professor of Epidemiology and Biochemistry, and Director of the Division of Ecology at the Hopkins School of Hygiene and Public Health, announced the development of a vaccine for one strain of the common cold. The virus is the JH virus (for Johns Hopkins), which Price isolated 4 years ago and which, in a 2-year study, was found to cause 30% of the cold cases examined. The vaccine proved to be 80% effective in treating the JH virus, and the work has been confirmed by three other laboratories.

"The JH virus was found in association with an upper respiratory outbreak in children.

"Children given a vaccine prepared from inactive JH virus showed an attack rate about 8 times lower than that of the children receiving the placebo injections.

"No untoward reactions were observed in 401 individuals receiving the vaccine, which was prepared from inactivated JH virus grown in monkey kidney epithelial tissue.

"It is concluded that the JH virus is the cause of the cold-like illness in humans and that an inactivated vaccine can be prepared from the virus which protects against the overt illness due to the JH virus."

### Cardiac Studies

A radioisotope technique for the determination of cardiac output which is said to offer "virtually unlimited potential" in the diagno-



sis and control of heart disease is described in a report of United States' Air Force Aero-medical Research. The non-traumatic method uses injection doses of radio-ionated human serum albumin. The technique is simple and highly accurate and can be used to demonstrate precisely the variations of certain cardiac output under stress and response to medications.

#### Soil Moisture Content

The development of a neutron meter by scientists of the Western Province Fruit Research Station has made it possible to determine the moisture content of soil in, literally, a minute. The standard oven-drying method takes 16 hours and, moreover, requires the transportation of the soil sample to a laboratory. The new instrument can be operated easily in the field by one person, and so many measurements can be made that errors due to the use of samples are reduced.

The radioactive source consists of 10 milligrams of radium mixed with beryllium powder.

#### Electrodeposition and Metal Finishing

The India Section of the Electrochemical Society held a Symposium on 'Electrodeposition and Metal Finishing' at the Central Electrochemical Research Institute, Karaikudi, on December 27 and 28, 1957. There were 35 papers covering the theoretical and industrial aspects of electroplating, electrorefining, electrowinning, metal powders, anode phenomena, electropolishing, anodizing and protective coatings. The Section proposes to publish a Special Number covering the Proceedings of the Symposium.

#### Zoological Nomenclature

The International Trust for Zoological Nomenclature has announced that arrangements have been made for the immediate publication in book form of the first instalment of each of the *Official Lists* of valid zoological names and of the corresponding *Official Indexes* of rejected and invalid names, together with

the first instalments of the *Official Lists* of works approved as available for Zoological Nomenclature and of the *Official Indexes* of rejected and invalid works. The categories of names covered by these *Lists* and *Indexes* range from specific to ordinal names. The total number of entries contained in these instalments now to be published amounts to be about 5,000.

These *Lists* and *Indexes* have been prepared as a result of the decisions taken by the various International Congresses of Zoology held from time to time, starting from the Ninth Congress (Monaco, 1930) to the Fourteenth Congress (Copenhagen, 1953).

These *Official Lists* and *Official Indexes* constitute an important instrument devised to promote stability in Zoological Nomenclature and will thus be indispensable to all specialists engaged in taxonomic work in zoology and palaeontology.

Enquiries in regard to above publications should be addressed to the International Trust for Zoological Nomenclature at its Publication Office at 41, Queen's Gate, London, S.W. 7 (England).

#### Lady Tata Scientific Research Scholarships, 1958-59

The Trustees of the Lady Tata Memorial Trust are offering six scholarships of Rs. 250 each per month for the year 1958-59 commencing from 1st July 1958. Applicants must be of Indian nationality and *Graduates in Medicine or Science* of a recognised University. The scholarships are tenable in India only and the holders must undertake to work whole-time under the direction of a scientist of standing in a recognised research institute or laboratory on a subject of scientific investigation that must have a bearing either directly or indirectly on the alleviation of human suffering from disease. Applications must conform to the instructions drawn up by the Trust and should reach by March 15, 1958. Candidates can obtain these instructions and other information they desire from the Secretary, the Lady Tata Memorial Trust, Bombay House, Bruce Street, Fort, Bombay-1.

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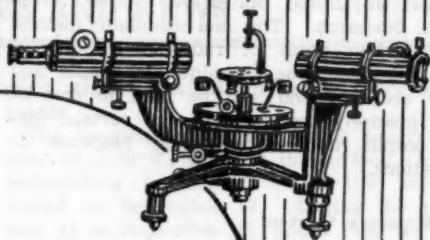
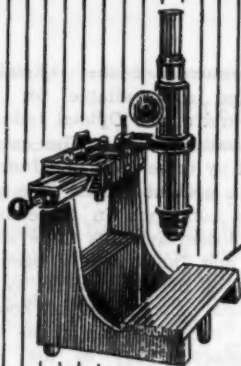
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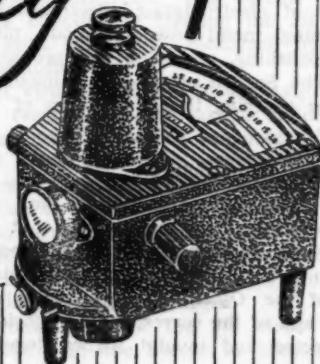
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